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THE EARLY PROMISE OF AMERICAN MARITIME POWER.

By Alexis de Tocqueville.

THE building of the new United States navy; the rapid development of our ship-building industry, particularly on the Great Lakes; the increasing volume and variety of our export trade; and the astonishing spread of popular interest in yacht-racing and nautical sports of all kinds, these are broad facts which show clearly enough that the American people are rousing themselves to a livelier interest in shipping affairs, and that we have undoubtedly entered upon a new era in the development of our maritime interests.

For thirty years past the American people have been engrossed in the development of our great west, in the building of new cities and towns, and in the construction of our vast railroad systems. As a rule, therefore, Americans of the present generation know nothing and have heard little of shipping interests. They have had neither taste or time for it, because other fields of activity were more promising and more profitable. To most of our readers, therefore, it may seem like romance to talk of those times in the past when American shipping was our pride and boast, and when we challenged England's leadership in the carrying-trade of the world. But the sounding statement is sustained by the sober facts, and happily we are able to present disinterested corroborative testimony of so high authority that it cannot be questioned.

Alexis de Tocqueville enjoys just and enduring fame as one of the greatest critical and philosophical writers of all time. In his celebrated work "Democracy in America" the great Frenchman devoted a chapter to describing American shipping as he saw it sixty years ago,

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and it is from these pages that the following significant extracts are taken. They come as a fitting sequel to Mr. Nixon's interesting and forcibly-written paper in our last number, because the facts show that, without orders for war-ships, without subsidies from the government, and in spite of the higher cost of operating American ships, we yet built up a carrying-trade in American bottoms which challenged the admiration of the world—precisely as we have done in recent years on the Great Lakes. We do not underestimate the value to shipping interests of the government's orders for war-ships, and we have gladly opened our pages to a presentation of the subject from the ship-builder's point of view. But we pin our faith to individual enterprise, to the inventive genius and the capacity for business which our people have shown; and, with or without orders for war-ships, we look for a continuous and rapid expansion of our ship-building industry and our shipping interests. The United States has become the world's center for the cheap production of iron and steel. That fact of itself will ultimately give us "the paramount control of the commerce of the world," as Mr. Atkinson has so confidently predicted.—THE EDITOR.

The coast of the United States from the bay of Fundy to the Sabine river in the gulf of Mexico is more than two thousand miles in extent. These shores form an unbroken line, and they are all subject to the same government. No nation in the world possesses vaster, deeper, or more secure ports for shipping than the American.

The inhabitants of the United States constitute a great civilized people, which fortune has placed in the midst of an uncultivated country, at a distance of three thousand miles from the central point of civilization. America consequently stands in daily need of European trade. The Americans will, no doubt, ultimately succeed in producing or manufacturing at home most of the articles which they require; but the two continents can never be independent of each other, so numerous are the natural ties which exist between their wants, their ideas, their habits, and their manners.

The union produces peculiar commodities which are now become necessary to us, but which cannot be cultivated, or can only be raised at an enormous expense, upon the soil of Europe. The Americans only consume a small portion of this produce, and they are willing to sell us the rest. Europe is, therefore, the market of America, as America is the market of Europe; and maritime commerce is no less necessary to enable the inhabitants of the United States to transport their raw materials to the ports of Europe than it is to enable us to supply them with our manufactured produce. The United States

were, therefore, necessarily reduced to the alternative of increasing the business of other maritime nations to a great extent, if they had themselves declined to enter into commerce, as the Spaniards of Mexico have hitherto done ; or, in the second place, of becoming one of the first trading-powers of the globe.

The Anglo-Americans have always displayed a very decided taste for the sea. The declaration of independence broke the commercial restrictions which united them to England, and gave a fresh and powerful stimulus to their maritime genius. Ever since that time the shipping of the union has increased in almost the same rapid proportion as the number of its inhabitants. The Americans themselves now transport to their own shores nine-tenths of the European produce which they consume. And they also bring three-quarters of the exports of the new world to the European consumer. The ships of the United States fill the docks of Havre and of Liverpool, while the number of English and French vessels which are to be seen at New York is comparatively small.

Thus not only does the American merchant face competition in his own country, but he even supports that of foreign nations in their own ports with success. This is readily explained by the fact that the vessels of the United States can cross the seas at a cheaper rate than any other vessels in the world. As long as the mercantile shipping of the United States preserves this superiority, it will not only retain what it has acquired, but it will constantly increase in prosperity.

It is difficult to say for what reason the Americans can trade at a lower rate than other nations, and one is at first led to attribute this circumstance to the physical or natural advantages which are within their reach ; but this supposition is erroneous. The American vessels cost almost as much to build as our own ; they are not better built, and they generally last for a shorter time. The pay of the American sailor is more considerable than the pay on board European ships,—which is proved by the great number of Europeans who are to be met with in the merchant vessels of the United States. But I am of opinion that the true cause of their superiority must not be sought for in physical advantages, but that it is wholly attributable to their moral and intellectual qualities.

The following comparison will illustrate my meaning. During the campaign of the revolution the French introduced a new system of tactics into the art of war, which perplexed the oldest generals and very nearly destroyed the most ancient monarchies in Europe. They undertook (which had never before been attempted) to make shift without a number of things which had always been held indispensable in warfare ; they required novel exertions on the part of their troops,

which no civilized nations had ever thought of; they achieved great actions in an incredibly short space of time; and they risked human life without hesitation to obtain the object in view. The French had less money and fewer men than their enemies; their resources were infinitely inferior; nevertheless, they were constantly victorious, until their adversaries chose to imitate their example.

The Americans have introduced a similar system into their commercial speculations; and they do for cheapness what the French did for conquest. The European sailor navigates with prudence; he only sets sail when the weather is favorable; if an unseen accident befalls him, he puts into port; at night he furls a portion of his canvas; and, when the whitening billows intimate the vicinity of land, he checks his way, and takes an observation of the sun. But the American neglects these precautions and braves these dangers. He weighs anchor in the midst of tempestuous gales; by night and by day he spreads his sails to the wind; he repairs as he goes along such damages as his vessel may have sustained from the storm; and, when he at last approaches the term of his voyage, he darts onward to the shore as if he already descried a port. The Americans are often shipwrecked, but no trader crosses the seas so rapidly. And, as they perform the same distance in a shorter time, they can perform it at a cheaper rate.

The European touches several times at different ports in the course of a long voyage; he loses a good deal of precious time in making the harbor, or in waiting for a favorable wind to leave it; and he pays daily dues to be allowed to remain there. The American starts from Boston to go to purchase tea in China; he arrives at Canton, stays there a few days, and then returns. In less than two years he has sailed as far as the entire circumference of the globe, and he has seen land but once. It is true that during a voyage of eight or ten months he has drunk brackish water, and lived on salt meat; that he has been in a continual contest with the sea, with disease, and with the tedium of monotony; but, upon his return, he can sell a pound of his tea for a half-penny less than the English merchant, and his purpose is accomplished.

I cannot better explain my meaning than by saying that the Americans affect a sort of heroism in their manner of trading. But the European merchant will always find it very difficult to imitate his American competitor, who, in adopting the system which I have just described, follows, not only a calculation of his gain, but an impulse of his nature.

The inhabitants of the United States are never fettered by the axioms of their profession; they escape from all the prejudices of their

present station; they are not more attached to one line of operation than to another; they are not more prone to employ an old method than a new one; they have no rooted habits, and they easily shake off the influence which the habits of other nations might exercise upon their minds, from a conviction that their country is unlike any other, and that its situation is without a precedent in the world.

This perpetual change which goes on in the United States, these frequent vicissitudes of fortune, accompanied by such unforeseen fluctuations in private and in public wealth, serve to keep the minds of the citizens in a perpetual state of feverish agitation, which admirably invigorates their exertions and keeps them in a state of excitement above the ordinary level of mankind. The whole life of an American is passed like a game of chance, a revolutionary crisis, or a battle. As the causes are continually in operation throughout the country, they ultimately impart an irresistible impulse to the national character. The American, taken as a chance specimen of his countrymen, must, then, be a man of singular warmth in his desires, enterprising, fond of adventure, and, above all, of innovation. The same bent is manifest in all that he does; he introduces it into his political laws, his religious documents, his theories of social economy, and his domestic occupations; he bears it with him in the depth of the backwoods, as well as in the business of the city. It is the same passion, applied to maritime commerce, which makes him the cheapest and the quickest trader in the world.

As long as the sailors of the United States retain these inspiriting advantages, and the practical superiority which they derive from them, they will not only continue to supply the wants of the producers and consumers of their own country, but they will tend more and more to become, like the English, the factors of all other peoples. This prediction has already begun to be realized; we perceive that the American traders are introducing themselves as intermediate agents in the commerce of several European nations; and America will offer a still wider field to their enterprise.

It is unquestionable that the Americans of the north will one day supply the wants of the Americans of the south. Nature has placed them in contiguity, and has furnished the former with every means of knowing and appreciating those demands, of establishing a permanent connection with those States, and of gradually filling their markets. The merchant of the United States could only forfeit these natural advantages if he were very inferior to the merchant of Europe, to whom he is, on the contrary, superior in several respects. The Americans of the United States already exercise a very considerable moral influence upon all the peoples of the new world. They are the

source of intelligence, and all the nations which inhabit the same continent are already accustomed to consider them as the most enlightened, the most powerful, and the most wealthy members of the great American family. All eyes are, therefore, turned toward the union; and the States of which that body is composed are the models which the other communities try to imitate to the best of their power: it is from the United States that they borrow their political principles and their laws.

The Americans of the United States stand in precisely the same position with regard to the peoples of South America as their fathers, the English, occupy with regard to the Italians, the Spaniards, the Portuguese, and all those nations of Europe which receive their articles of daily consumption from England, because they are less advanced in civilization and trade. England is at this time the natural emporium of almost all the nations which are within its reach; the American union will perform the same part in the other hemisphere; and every community which is founded, or which prospers, in the new world is founded and prospers to the advantage of the Anglo-Americans.

If the union were to be dissolved, the commerce of the States which now compose it would undoubtedly be checked for a time; but this consequence would be less perceptible than is generally supposed. It is evident that, whatever may happen, the commercial States will remain united. They are all contiguous to each other; they have identically the same opinions, interests, and manners; and they are alone competent to form a very great maritime power. Even if the south of the union were to become independent of the north, it would still require the service of those States. I have already observed that the South is not a commercial country, and nothing intimates that it is likely to become so. The Americans of the south of the United States will, therefore, be obliged, for a long time to come, to have recourse to strangers to export their produce, and to supply them with the commodities which are requisite to satisfy their wants. But the northern States are undoubtedly able to act as their intermediate agents cheaper than any other merchants. They will, therefore, retain that employment, for cheapness is the sovereign law of commerce. National claims and national prejudices cannot resist the influence of cheapness.

Nations, as well as men, almost always betray the most prominent features of their future destiny in their earliest years. When I contemplate the ardor with which the Anglo-Americans prosecute commercial enterprise, the advantages which befriend them, and the success of their undertakings, I cannot refrain from believing that they will one day become the first maritime power of the globe. They are born to rule the seas, as the Romans were to conquer the world,

STANDARDIZING THE TESTING OF IRON AND STEEL.

By P. Kreuzpointner.

AMID the lavish praises of the civilizing influences of steam and electricity, it is well not to forget the merits of the vehicles by the aid of which we are enabled to make these civilizing agencies practically useful for every-day life. Iron and steel being the transmitters and conveyers of electricity and the expansive force of steam, these metals may be considered the foundation, upon which the superstructure of our intellectual and material life rests and moves.

What is it in the nature of iron and steel that enables these metals to perform the herculean task of carrying the world's commerce and industry, and to meet and ward off successfully the impetuous onslaught of sudden impact as well as the invisible, but none the less active, forces of measureless strains, which gradually weaken and undermine the strength and soundness of these metals? Indeed, endless are the disguises under which the enemies of iron and steel try to cause a break or a wreck. And since, however stubborn the resistance, wear will eventually cause the breakdown of the strongest structure, a cloud of invisible particles of iron and steel is strewn along their paths to the grave.

Considering the ever-active forces at work to destroy metals, and the ever-present necessity of reducing cost, the engineer has a continual battle with the problem of so building his structure as to secure the greatest safety and durability and consume the least metal. Familiarity with the qualities of iron and steel is, to both engineer and manufacturer, a question of the survival of the fittest.

When inquiring into the serviceableness of iron and steel for structural purposes, it is well to free our mind from the idea that these metals are rigid, immovable bodies with a power of resistance that does not change until they are worn out or break under an overwhelming force. Contrary to the popular theory, iron and steel are sensitive, susceptible to outside impressions,—sometimes giving way readily to the influence of gentle persuasion. The fact is that all metals, even the hardest steel, are plastic and elastic, their plasticity and elasticity differing only in degree, not in kind. In other words, iron and steel flow like viscous bodies, under the application of sufficient time and pressure, or heat,—some grades more quickly than others. Nor does it take very great pressure to set even hard steel in motion. If, however, a not too great pressure be taken off before any per-

manent distortion has taken place, the metal will return to its original shape or dimensions, and, according to the greater or less degree in which a metal does this, the more or less it is elastic. This difference in the elasticity of iron and steel is again, like plasticity, one of degree only, not of kind, though, the greater the degree of plasticity of a grade of iron and steel, the less the pressure necessary to make it flow, the less the degree of elasticity. The elasticity of iron and steel decides their value for a given purpose, and the engineer who knows best how to make use of that property and the best method of ascertaining its degree will, other things being equal, build the safest and most durable structure, because it has been proved that, as long as a structure is not strained beyond the elastic limit, it is practically indestructible.

Iron and steel are very much averse to having their virtues pried into and measured by thumb-rule. They must be approached with the delicacy that we show in approaching a high-bred, sensitive person.

That this is no mere figure of speech may be strikingly shown by an instance that came under the personal observation of the writer. At one time he was testing a bar of spring steel 1 inch wide, ⅜ inch thick, and 20 inches long, with a tensile strength of 110,000 pounds per square inch. To ascertain the elastic limit, suitable micrometers measuring to the ten-thousandth part of an inch had been attached to the ends of the test-piece with wires leading to an electric bell and so causing it to ring whenever the points of the micrometers came in contact. When the piece was stretched, however slightly, contact was broken, and the bell ceased to ring. The number of revolutions of the screw necessary to renew contact indicated the amount of stretch for a given load. Just at the beginning, the test was stopped. Some visitors coming in, one of them explained how test-pieces are pulled apart, and, in the course of his explanation, picked up the spring-steel test-piece and pulled at the ends with both hands to indicate the action of the testing-machine. Thereupon the electric bell ceased to ring. The gentleman had stretched or bent the piece sufficiently to break the contact. It seemed incredible that any person could stretch a piece of spring steel 1 inch wide and ⅜ inch thick with his hands. But there was no doubt about it. It was tried again and again by various persons, and the experiment succeeded almost every time. Now, if a man can stretch or bend a piece of spring-steel with his hands, what must be the effects of heavy loads?

And yet there are not a few persons, with knowledge and without knowledge, who denounce testing as a superfluous refinement of some cranky engineer, or who admit testing only as a sort of necessary evil, to be executed by any method or no method, as fancy may dictate.

With Bauschinger's celebrated mirror apparatus, it is possible to measure stretch to the $\frac{1}{25000}$ part of a millimeter, and it has been found that, even with the small loads necessary to stretch a piece of steel to that trifling extent, there is still a permanent set taking place. In other words, there is, theoretically, no elastic limit. In practical engineering, however, these small stretches are not taken into consideration, and it has been agreed to call the elastic limit that point where the stretch begins to increase faster than the load.

For instance, if the load applied is 10,000 pounds, and the stretch is $\frac{1}{1000}$ of an inch, stretch and load are still proportional to each other, and the elastic limit has not yet been reached. But, if the load is 11,000 pounds and the stretch is now $\frac{13}{10000}$ of an inch, load and stretch have become disproportional, and the elastic limit is supposed to have been reached. In every-day practice, however, we have to deal not only with this comparatively simple question of ascertaining the quality of a given metal, or grade of metal, but with the processes of melting, heating, rolling, and cooling, which introduce a multiplicity of variations in quality of greater or less influence on its durability for a given purpose, and therefore more or less complicate the work ascertaining its reliability.

So far I have attempted briefly to show that iron and steel are not the rigid, immovable, uniform bodies that many suppose them to be. As a consequence of this plasticity, it has become imperative, on account of the ever-widening circle of application, to carefully ascertain the suitability of the various grades of steel for various purposes.

It is well known that this is done by pulling, twisting, bending, nicking, punching, etc. It does not seems to be so well known, though, that not every method is suitable. In the absence of an agreement as to the best method, much time and money are spent with no other effect than that of needlessly increasing cost of production. Economic conditions have imposed upon us the necessity of adopting uniform methods in commercial transactions and industrial pursuits.

We have uniform measures of quantity; why not also uniform measure of quality of metals? The yard or meter, pound or kilogram, quart or liter, are the same everywhere. But the quality of a ton of steel is determined chiefly by the more or less fragmentary knowledge the engineer or consumer may happen to possess of the properties of steel, or, in some instances, by mere opinion and fancy. If we add to this the honest differences that may arise as to the value of a certain method of testing,—differences due to the fact that one engineer has to deal more or less exclusively with one class of metal, and thus is apt to jump at conclusions and apply his observations to all similar materials,—then we have, as a result, a hotch-potch of opinions and

methods not at all warranted by facts, or creditable to our intelligence. Thus we have a different measure of quality of steel in every State and city, and we often find different measures in the same building, if not in the same engineering office. As Mr. E. Schroedter, secretary of the Society of German Iron Masters, said at the last convention of the International Union for the Unification of Methods of Testing: "The specifications for iron and steel for all kinds of construction vary not only in the different industrial countries, but, on closer examination of the details of the individual specifications, an extraordinary difference is found."

"While a strength of 72,000 pounds per square inch is asked for in one case, another purchaser prescribes 112,000 pounds per square inch. For structural material which is used in hundreds of thousands of tons for bridges and buildings, one engineer asks for material of 57,000 pounds per square inch with an elongation of 20 per cent. in 8 inches, while another one asks for 71,000 pounds per square inch."

"Still greater differences are found in specifications for sheets and steel castings. Not only are there great differences for quality, but there are also no uniform methods of testing and inspection."

While writing this, there march before the writer's mind, in single file, nine different test-sections of boiler steel, to measure the quality of steel for boilers. There may be others of which he does not know. Now, has boiler steel changeable properties, so that nine different measures are required as a guarantee, or is each of these measures correct, giving a true insight into the ability of the metal to resist pressure, and the effect of contraction and expansion to which steel in boilers is subject?

For other classes two, three, or four different specifications have to be filled. In a certain steel works where tires are rolled one hundred and twenty-eight sets of rolls are available, in order that all fancies may be suited. Allowing a liberal margin for necessary variations and individual judgment, thirty sets should be ample.

Who will eventually pay for the cost of making and maintaining the extra ninety-eight sets of tire-rolls, and the bother of using and changing them? Transportation, of course, will be burdened eventually with that cost. If it be urged that the cost per pound, distributed over the total number of pounds produced, is small, then why practise economy in any department of manufacture or transportation? Once the fact is fairly understood that we may get erroneous results by one method and reliable results by another, we shall have made a long stride forward to the unification of methods of testing. The object of all our testing and inspection of iron and steel, with but few exceptions, is to ascertain the rate of flow of a given metal and the force or load necessary to make it flow. The former indicates the degree of

its ductility, and the latter its strength. Does a piece of metal or test-piece, representing a larger quantity of the same metal, show the same rate of flow under all circumstances, in whatever shape or at whatever speed the piece of iron or steel may be tested? It does not. If the test-piece is not of the proper size and shape, the flow will vary as the size and shape of the test-piece, and, if it takes more pressure or load to make the metal flow in one test-piece than in another, that test-piece will be faulty, and the result of the test will be erroneous and misleading by the difference in the loads respectively necessary to make the metal flow in a properly-shaped and an improperly-shaped test-piece. In other words, the results of one test will be different from those of the other test, other things being equal, and the engineer or consumer may deceive himself by just that difference.

If that difference is less than it ought to be, he assumes his material to be weaker than it really is, and takes more metal than he needs; if that difference is more than it ought to be, then the engineer assumes that his metal has greater strength than it really has, and his structure will be weaker than it ought to be. The criterion, therefore, of the most reliable method of testing is the selection of a test-piece of such shape and size that the metal will begin to flow, and flow at the same rate, under a pressure approximately equal to that which would cause the same metal to flow in the structure itself.

In the above we have not taken into consideration the factor of speed and other minor influences which go to make up the value of a proper method of testing.

To illustrate the foregoing let us assume that the engineer has based his calculations upon a limit of elasticity of, say, 30,000 pounds per square inch, and a breaking strength of 55,000 pounds per square inch. Now, if the method of testing, including shape of test-piece, speed of testing, and all other factors that may influence the result, show the metal to have a limit of elasticity of 38,000 pounds per square inch and a strength of 58,000 pounds per square inch,—and such differences can easily be produced,—then it is evident that the engineer is tempted to reduce the dimensions of his structure to save metal, and thereby make it too weak.

Now, since we have seen that there should be a uniform and standard shape and size of test-piece and methods of testing, how can we determine the proper dimension of test-pieces, leaving out of consideration minor details. If we take a beam, an eyebar, a rail, a girder, an axle, or a tire, and test it to destruction, noting carefully the behavior of the metal at the various stages of the performance, we learn when and how the structure begins to give way.

It has even been proposed to carry this into practice and test every

axle, tire, eyebar, etc., before using it. However, since this would be expensive and not always practical, we make use of the information gained by testing whole structures to destruction.

If we now take two test-pieees of the material we intend to use for axles, beams, etc., and shape them like Nos. 1 and 2, test them, and compare the figures with the results obtained on the whole structure, we find a very marked difference between No. 1 and No. 2, and a still greater difference between No. 1 and the whole piece.

The difference between No. 2 and the whole structure is found to be comparatively small.

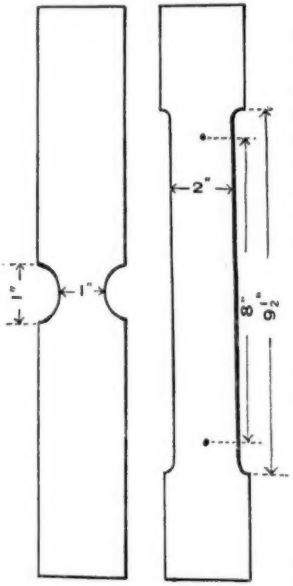


FIG. 1. FIG. 2.

It is thus evident that the size and form of No. 2 more nearly represent the behavior of the metal when subjected to the same stresses in the whole structure than do those of No. 1. By a series of tests with various shapes and sizes we find that, as we depart from size and shape No. 2, we alter the results, and, the further we depart, the nearer we get to the results obtained with No. 1.

This clearly shows that the size and shape of a test-piece alters, modifies, retards, or accelerates the flow of the metal; hence that size is obviously the proper one which comes nearest to the behavior of the metal in the whole piece, and it should be the recognized standard.

It is needless to say that, within practical limits of economy and expeditiousness, the amount of metal in the test-section should be as large as possible, because it is impossible to make the metal so uniform that a small piece will represent the possible variations found in a plate or billet. A proper test-piece, then, is one that includes the greatest practicable number of particles of iron or steel in the same position, the same arrangement, the same physical and chemical state, as those in which they exist in the whole beam, axle, gun, or other structure. For various reasons it is manifestly impossible to have a single size and shape in all industrial countries and for all purposes.

Nor is this necessary, for, within certain limits, the results of tests

with slightly different test-pieces are practically alike, and it is useless to try to squeeze the properties of metals for a given purpose within the strait jackets of cast-iron lines and formulas.

However, the above-mentioned principle should be a guide, and it seems to offer the best rational solution of the question, greatly reducing the element of chance. The recommendations of the International Union for the Unification of Methods of Testing Structural Material, which are not binding on its members, but only advisory, similar recommendations of a French commission, and those of the American Society of Mechanical Engineers, all tend in that direction, and would, if universally adopted, be a great step forward.

In the following tables of results of tests we can clearly perceive the influence of the form of the test-piece, while Barba's results of tests with geometrically similar and geometrically dissimilar test-pieces have ever been, and are still, authoritative in emphasizing the results of every-day experience. The reason for the higher strength and elongation in short test-sections seems to be that the fillets of the test-piece retard the flow, so that the particles, instead of sliding past each other naturally, are forcibly torn apart, to effect which a greater load is necessary. On the other hand, all the stretch takes place at or near the fracture, and, the section being short, there is a maximum of stretch to the inch, which is the unit of measure ment.

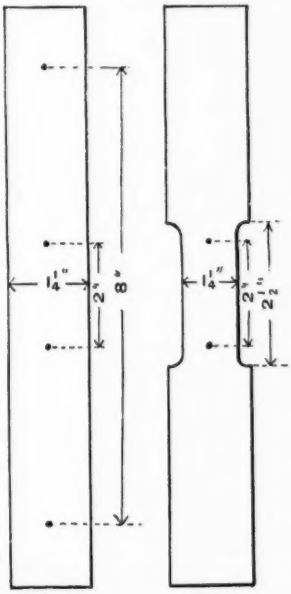


FIG. 4. FIG. 3.

In a long section, as well as in a whole structure, the parts furthest away from the fracture do not stretch so much, and this reduces the percentage of stretch per inch. We can see this in Figs. 3 and 4. The tensile strength of No. 3 was 60,000 pounds per square inch with 46 per cent. of elongation in 2 inches, while the tensile strength of No. 4, which was cut out alongside No. 3, was 58,930 pounds per square inch with 54 per cent. of elongation in 2 inches, while the elongation was only 26 per cent. when measured in 8 inches, as shown. In No. 3 the flow of the particles was retarded by shoulders and fillet, and the particles were torn

apart before they could slide apart. But, the section being short, the stretch at the point of fracture covered nearly the measurable length of section. In No. 4 there was no such hindrance, except what was caused by the grips, and the particles had a chance to follow their natural trend. Hence we find the strength somewhat lower; the elongation in 2 inches high again, but lower when measured in 8 inches.

Tables I and II show the results of tests made as the material came from the rolls, without preparation of any kind. They illustrate the difference between measuring the elongation in 2 and in 8 inches on the same bar.

TABLE I.—STAYBOLT IRON.

	Tensile Strength in 8 inches.	Elongation in 8 inches.	Elongation measured in 2 inches on an 8-inch section.	Excess in 2-in. section.
	Pounds per sq.in.	Per cent.	Per cent.	Per cent.
	48,800	29	45	16
	49,790	30	46	16
	49,300	30	43	13
Average.	49,270	29.7	44.7	15

TABLE II.—MERCHANT BAR STEEL.

	59,300	28	50	22
	59,000	29	46	17
	58,800	27	45	18
Average.	59,033	28	47	19

Table III shows the differences in results given by properly-proportioned test-pieces of boiler steel of 2-inch and 8-inch section. Table IV shows similar results obtained with much harder axle-steel. In both these tables it will be seen how much higher in strength and elongation the 2-inch section makes the metal appear. If the engineer takes this section as his measure of quality, he will assume that he has a strong and ductile metal, which is an absurdity, since ductility does not increase with increase of strength and rigidity. Since the 8-inch section represents more metal, it is fair to assume that the results obtained with that section are more truly representative of the quality of the metal than those obtained with the 2-inch section.

In Table V we see what extreme differences there are in results obtained with a 1-inch and an 8-inch section, as in Fig. 1 and Fig. 2.

Table V, as well as Table VI, explains how the strength of a structure may sometimes entirely depend on the knowledge an engineer or consumer may have of the value of one or the other method of testing as a measure of quality of structural material; and how desirable it is to have uniform methods of testing.

TABLE III.—BOILER STEEL.

	Tensile strength in 8-inch section.	Tensile strength in 2-inch section.	Elongation in 8-inch section.	Elongation in 2-inch section.
	P'nds per sq. in.	P'nds per sq. in.	Per cent.	Per cent.
	57,200	58,800	26	36
	55,600	57,300	31	38
	59,800	61,400	23	32
	62,100	64,700	26	32
Average.	58,675	60,450	26.5	34.5

TABLE IV.—AXLE STEEL.

	Tensile strength in 8 in. section.	Tensile strength in 2-in. section.	Elongation measured in 8 inches.	Elongation measured in 2 inches.	Elongation measured in 2 in. on an 8-in. section.
	P'nds p. sq. in.	P'nds sp. q. in.	Per cent.	Per cent.	Per cent.
	88,900	92,400	22	25	36
	87,500	92,200	22	26	37
	86,500	91,800	22	27	36
	86,400	91,500	18.5	27	35
Average.	87,325	91,975	21.1	26.2	36

TABLE V.—RESULTS OF TESTS WITH GEOMETRICALLY DISSIMILAR TEST-PIECES.

Length of section, in inches.	Dimensions of Test-Pieces.		Tensile strength, pounds per square inch.	Elongation, per cent
	Thickness, inches.	Width, inches.		
1	½	1½	71,900	27
2	½	1½	65,100	26.5
4	½	1½	62,600	21
6	½	1½	60,300	19
8	½	1½	59,000	18.5

TABLE VI.—DIFFERENCES OF ELONGATION WITH GEOMETRICALLY DISSIMILAR TEST-PIECES.

Length of section, in inches.	Thickness of Plate $\frac{5}{16}$ inches.			Thickness of Plate ½ inch.		
	Width of Section.			Width of Section.		
	2½ in.	1½ in.	½ in.	2½ in.	1½ in.	½ in.
	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.
1	66	55	45	67	61	55
2	49	35	33	50	43	40
4	36	25	24	36	31	30
6	29	21	19	30	26	26
8	27	18	15	27	24	23

Table VII gives part of the results of Barba's researches as to the value, as quality measures, of geometrically similar and dissimilar test-sections. These results have been universally recognized as proof that the dimensions of a test-piece must be proportional to each other,—that length and breadth, or diameter, must harmonize. Thus, if we depart from the proper proportion in length and breadth, or length and diameter, we get higher or lower results, according as the test-piece is too long or too short.

TABLE VII.—BARBA'S RESULTS OF TESTS WITH GEOMETRICALLY SIMILAR TEST-PIECES.

Diameter of test pieces, in inches.	Length of section, in inches.	Elastic limit, pounds per square inch.	Tensile strength, pounds per square inch.	Elongation in 2 inches.
		EXTRA SOFT STEEL.		
8/16	2	35,300	53,600	30.5
3/8	4	35,200	52,400	30.5
3/4	8	35,300	53,500	81
		MODERATELY HARD STEEL.		
1/4	2	34,200	59,700	33
3/8	3	34,200	59,700	33
1/2	4	34,400	59,900	33
5/8	5	34,000	59,300	34.5
7/8	6	33,900	59,200	33
1	7	34,200	58,200	33
1 1/8	8	34,300	56,900	33
		HARD STEEL.		
1/4	2	50,500	92,200	20
3/8	3	52,000	92,300	19
1/2	4	50,800	90,800	18
5/8	5	54,000	90,000	18
7/8	6	57,800	90,300	18
1	7	54,200	90,200	18
1 1/8	8	54,200	91,000	19

All that has been said thus far goes to show that, other things being equal, the largest and geometrically proportionate test-piece is, theoretically as well as practically, the one that comes nearest to representing the quality of the material in the whole structure, and should be the accepted and recognized standard for structural iron and steel. So far, the discussion has followed the general principles involved and a formal presentation of proof in the shape of tabulated results. In the concluding portion of the article, to appear in the next number of THE ENGINEERING MAGAZINE, the points enunciated will be graphically illustrated.

SOME IMPORTANT MINING-TUNNELS IN COLORADO.

By Thomas Tonge.

THE increasing demand for, and appreciation in value of, gold; the depreciation of the gold price of silver, resulting in a narrower margin of profit on the richer ores carrying gold and silver, or silver only; the closing-down of many mines producing only medium- or low-grade silver ore; and the natural progress and improvement in the mining industry,—all aiming at greater economy of production and operation on strict business principles,—have rendered new methods absolutely necessary. This is seen in the improved drilling apparatus, the increased use of electricity for power, more economic methods of conveying the ore from the mine to the mill or the railroad (in the shape of aerial wire tramways and tunnels), reduced railroad freight charges, new ore-treatment processes, and reduced ore-treatment charges.

Many persons residing at a distance from mining districts have the most erroneous ideas as to the supposed simplicity and enormous profits of mining, apparently deriving their information from the data of phenomenal assays, or occasional pockets of rich ore, mistakenly assuming that such cases are average samples, and that ore can be dug almost as potatoes are dug. On the contrary, with the exception of a very few mines which may pay expenses from the grass roots down, successful mining to-day involves the maximum of practical experience, professional knowledge, and financial means. This is fully borne out by the following brief notice of some of the leading mining-tunnels of Colorado.

The outcrops of mineral-bearing veins or ledges are usually found on the steep, rocky slopes of high mountains, separated by deep and great gulches or ravines. As the veins usually dip into the solid interior of the mountains, shafts are sunk either on the veins themselves, ore being taken out as the process goes on, or in such proximity to the veins that they can be reached from the shafts by drifts or levels (which are really side tunnels from the shafts) and the ore stoped out and conveyed in small ore-wagons along such drifts or levels to the shaft, hoisted to the surface, and thence lowered down the steep mountain side to the nearest wagon-road leading to the mill or railroad. As the shafts are frequently hundreds of feet deep, and the mouths of the shafts frequently hundreds, if not thousands, of feet above the bottom

OUTCROP OF VEINS ON THE STEEP AND ROCKY SLOPES OF HIGH MOUNTAINS.

of the adjoining gulch or valley, the ore has to be hoisted by steam power to the surface (such steam power involving the conveyance of fuel from the valley to the shaft house), and from the mouth of the

A COLORADO MINE. 1500 FEET ABOVE THE VALLEY.

shaft conveyed down the steep mountain-side. Sometimes the mountain-sides are too steep for a wagon, in which cases pack-animals—mules or donkeys—are used for the conveyance of supplies to the mine and of ore therefrom.

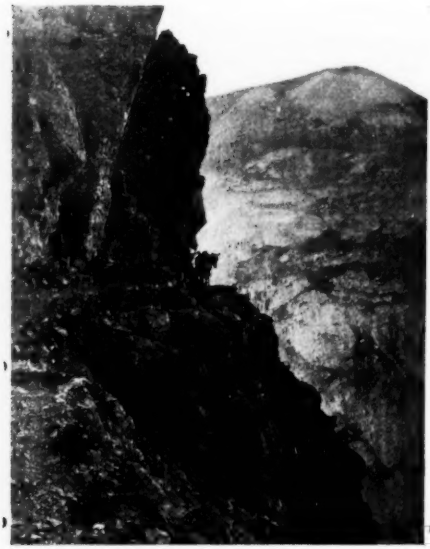
Again: it is frequently the case that, as the shaft increases in depth, water is encountered, which can be taken out (so as to permit the miners to work) only by pumping, thus involving expensive

A MOUNTAIN ROAD, COLORADO.

pumping-plants, in addition to the cost of hoisting the ore and subsequently getting it down the steep hill-side.

The expense of pumping, hoisting, and hauling seriously reduces the margin of profit, and in some cases extinguishes it altogether.

It is obvious that, under the above circumstances, through a tunnel driven into the mountain and reaching the ore bodies at a low level,—say, from the level of the bottom of the adjoining gulch,—



TRAIL FOR PACK ANIMALS, SAN JUAN MOUNTAINS, COLORADO.

not only can the ore be extracted from below and taken out almost by natural gravity or the minimum of power, thereby saving the expense of hoisting and subsequent conveying down the steep hillside, but also drainage can be had by natural gravity, thereby dispensing with the expensive pumping-plants, costly fuel, wages of engineers, etc.

Of course, not in every case is a tunnel feasible, and, in cases where it is feasible and where the circumstances will justify it, the interested parties may not have the necessary capital.

The last ten years have seen an increasing number of tunnel enterprises in Colorado, which may be divided into two classes: (1) those driven by mine-owners to develop their own properties; (2) those driven under the properties of other people, looking for revenue from the owners of such properties in the shape of royalties for the hauling of ore and the drainage afforded, and also looking to the probabilities of discovering, and thereby acquiring the ownership of, mineral-bearing veins which do not outcrop on the surface, and which have not been discovered under ground by the owners of the surface-workings. The question of *meum* and *tuum*, as between the owners of the tunnel and the owners of the surface mines, has probably not yet been finally settled. The important decision in the United States court at St. Louis as to the rights of tunnel sites—see Rico-Aspen Co. *vs.* Enterprise Co., 53d Federal Reporter, page 321—may have a very serious effect even on patented mines.

One of the first tunnels of any size in Colorado was the Bobtail tunnel at Blackhawk, Gilpin county, which was driven by manual labor in the "sixties," for the purpose of opening up the once famous Bobtail mine. Its original length was 1,200 feet, but 2,500 feet of

extension has been added, tapping adjoining properties. As its greatest depth is only 450 feet, and as several shafts in the immediate vicinity were sunk years ago to a much greater depth below the surface than the tunnel, its present utilization for ore shipments and drainage is necessarily limited. Contemporaneous with the Bobtail tunnel was the Burleigh tunnel at Georgetown, Clear Creek county, which was the first tunnel in the State to be driven by machine-drills.

The Revenue tunnel (altitude 10,300 feet) is located at the foot of Hendrick's mountain in Ouray county, about seven miles from the town of Ouray (altitude 7,721 feet), the nearest railroad point. The primary object of the tunnel was to reach and develop the vein of the Virginius mine and various intermediate veins, carrying both gold and silver,—principally the latter. The Virginius mine has underground workings consisting of shafts sunk from the surface and levels extending from the shafts, aggregating nearly four miles in length, the output of gold and silver to date being about $3,000,000. The tunnel was commenced in the fall of 1887, and completed in 1891, work being almost continuous during that period, either on the tunnel itself or in "raises" or upward passages run from the tunnel to connect with the lower workings of the Virginius. The tunnel is 8 feet

CONCENTRATING MILL AT ENTRANCE OF REVENUE TUNNEL, ALTITUDE 10,300 FEET.

square; its total length to the intersection with the Virginius vein is 7,800 feet, or more than a mile and a third, from which intersection there is an extension on the vein for another half mile. From this extension the ore in the vein will be taken out from below, finally working up in such stoping to a vertical height of over 2,000 feet, for a length along the vein of 7,500 feet, the average width of the vein being about 5 feet. The greatest depth of the tunnel is 3,000 feet. It is equipped with a double track of 24-inch gage, operated by an electric motor. The total cost of the tunnel and of the water-power plant and other appliances immediately connected therewith (exclusive of mills) was $400,000, of which more than three-fourths was Colorado capital and the rest New York and Chicago capital. It is used both for ore shipments and drainage, and, without this tunnel and the reduced operating expenses effected thereby, the Virginius mine and adjoining properties would have had to close down in 1893 in consequence of the fall in the price of silver. The average value of the ore, as it goes into the mill, is about $20 per ton in silver and gold, and the following is the method pursued. The ore is brought out of the mine in small cars along the tracks in the tunnel and more than seven hundred feet of an outside extension thereof, to the top of a very large and completely-equipped concentrating mill of 300 tons' daily capacity (which cost upwards of $150,000), where it is concentrated, about five tons of ore being reduced to one ton of concentrates, the latter being then hauled to the railroad seven miles distant and shipped to the smelter two hundred and fifty miles distant. The concentrating mill is operated by electricity generated by water-power. Two water-power and electric plants which have cost upwards of $100,000 are in operation, and a third is approaching completion. Considering the large amount of capital invested in the mines, tunnel, mill, water-power, electrical plant, etc., the low grade of the ore, and the comparatively narrow margin of profit, this property is a striking illustration of the practical experience, professional skill, and competent management absolutely necessary in successful mining.

7800 FEET FROM THE TUNNEL ENTRANCE. MINERS GOING TO DINNER.

POWER-HOUSE, TIMBER-HOUSE AND BLACKSMITH SHOP, COWENHOVEN TUNNEL.

The zig-zag road up the mountain is the one up which supplies were hauled, and down which ore was packed, before the completion of the tunnel.

The Cowenhoven tunnel at Aspen is the most important enterprise of the kind in Colorado, and possibly the most successful in the United States. It was projected for the purpose of draining and furnishing transportation for the mines on Smuggler mountain, in all the deep mines on which the expenses of pumping have been steadily on the increase. In 1889 it became apparent that, unless some cheaper means of unwatering the mines and delivering the ore to the railroad tracks could be devised, the depth to which profitable mining could be carried on would soon be reached. When the tunnel was begun, the rates for drainage offered to the different mining companies were approximately equal to what they were then paying for pump-men's wages alone, and the rate for haulage, in round numbers, was one-half of the cost to the mining companies for conveying the ore by pack-animals or wagons from the mouths of the mines down to the railroad tracks at the foot of the mountain. Commencing near the tracks of the Denver & Rio Grande Railroad and the Colorado Midland Railroad, the tunnel runs under Smuggler mountain, and drains about thirty different mines, owned by six large consolidations. All ore produced on such properties, whether above or below the level of the tunnel, now comes through the tunnel, in most cases the ore cars

MULE TRAIN COMING OUT OF COWENHOVEN TUNNEL.

being loaded at the stopes and, without break of bulk, unloaded at the ore bins at the railroad tracks; in fact, all hoisting of ore and pumping of water to the surface of the mountain are now dispensed with, and the operating expenses greatly reduced. But for this, the majority, if not all, of these properties would have closed down in 1893 after the closing of the Indian mints, the repeal of the silver-purchasing clauses of the Sherman act, and the subsequent fall in the price of silver. The importance of this tunnel is shown by the fact that more than five hundred men pass through it to their work daily, while the daily output of ore and waste varies from three hundred to five hundred tons. In size it is 6 feet 8 inches high by 7 feet 8 inches wide, the present total length being 1¾ miles and the greatest depth 1,168 feet. The total cost, so far, has been $250,000, the money being furnished by three Colorado men. Work on the tunnel has been suspended since 1893, owing to the low price of silver, but, with more favorable conditions, it will be resumed, and the tunnel extended 2¾ miles to Woody creek, thus making the total length 4½ miles. It has a double track laid with 30-pound steel rails and is stone-ballasted throughout, and the tracks, switches, etc., have been laid with a view of introducing electric locomotives so soon as the improved price of silver justifies it. It is lighted from one end to the other by electricity, and equipped with the electric block-signal system. As illustrating the

difficulties experienced in driving such a tunnel may be cited the fact that in this case large underground caves filled with dolomite sand and water (a most treacherous combination in the nature of "quicksand") were often encountered, the contents of which flowed out, sweeping the workmen like chips before the thick flood. Notwithstanding such obstacles, the progress of the tunnel averaged more than ten feet per day, sometimes for months together, and in one single calendar month a length of not less than 421 feet 6 inches was completed.

In the vicinity of Aspen there are also the Compromise tunnel and the Woody tunnel,—both important enterprises.

The Smuggler-Union property near Telluride, San Miguel county, is another instance of the economy of operation effected by a tunnel. In every possible instance natural gravity is utilized, for which the location of the property is specially adapted. It is reached by a spur of the Rio Grande Southern Railroad. One hundred feet above the railroad track is the concentration mill, and 1,700 feet above that is the mouth of the tunnel, at an altitude of 10,900 feet above the sea-level. From the mouth of the tunnel the surface of the properties extends, claim after claim, to the number of seven, in endwise succession, for a distance of 1½ miles to the top of the mountain, the upper end of the upper claim being 13,300 feet high, or 2,400 feet higher than the mouth of the tunnel. The various claims are operated from the surface by levels, one after another, and the tunnel, 2,500

INTERIOR OF COWENHOVEN TUNNEL, OUTER 2000 FEET.

feet long, is connected with some of the upper levels by means of a shaft 700 feet deep. On the entire property there are about 25 miles of underground workings. The ore from the above-mentioned levels is lowered down the 700-foot shaft, passing thence through the 2,500-foot tunnel to its mouth, and is then carried by wire tramway down to the mill, if it be concentrating ore, or to the cars, if it be smelting ore. A large part of the value of the ores in these mines consists of gold. From the various claims now constituting the consolidated property, in former years and under previous ownerships, about $7,-

THE BREAST OF A TUNNEL, 1500 FT. BELOW THE SURFACE.

000,000 (according to smelter returns) was taken, and each of the mines accumulated a considerable dump; these dumps, eight or ten in number, aggregate, it is estimated, 150,000 tons, much of it mineral-bearing ore of low grade, which, under former conditions, could not be handled to pay expenses. By means of the shaft, tunnel and wire tramway, improved methods of concentrating, and reduced railroad and smelting charges, these large dumps of low-grade ore are now being worked at a profit. Under former management all supplies were conveyed to the mines, and the ore carried down from the mines on donkeys' backs, at a total cost of $5 per ton. By means of the

shaft, tunnel, and wire tramway, the same service is now performed at a gross cost of less than 50 cents per ton. The ore reserves are immense, and everything indicates that, working 200 men, it will take more than fifteen years to exhaust the mineral riches above the present level of the 2,500-foot tunnel. The whole property belongs to a private company consisting of a few wealthy men, 50 per cent. of the stock being held in Colorado, about 35 per cent. elsewhere in the United States, and about 15 per cent. in Europe and China. It is not listed on any stock exchange.

A BURRO PACK-TRAIN, COLORADO.

The Lamartine mine on French mountain near Idaho Springs, Clear Creek county, belongs to two private individuals in New York, and is credited with a total production of $3,000,000, mostly silver, its total underground workings aggregating about five miles in length. It is situated about five miles from the railroad, at an elevation of over

A BURRO PACK-TRAIN LADEN WITH ORE.

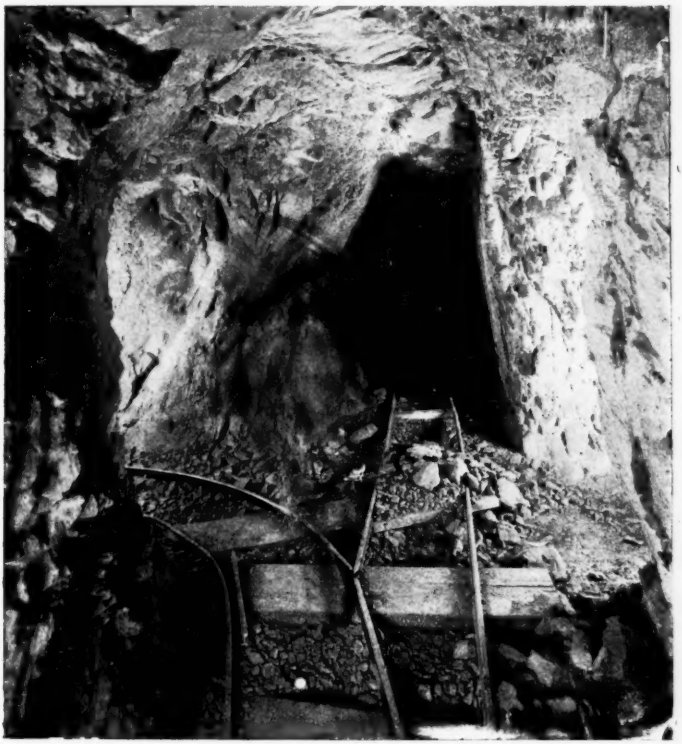
9,000 feet, or about 2,000 feet higher than the railroad. With the fall in the price of silver in 1893 and the increased inflow of water in the lower levels, it became a question of ceasing operations altogether, or driving a tunnel so as to dispense with the cost of hoisting ore or pumping water. The owners, as a preliminary, secured the control of mines on French mountain for a length of nearly two miles, with a greatest width of 1,600 feet, thus becoming direct owners of nineteen full claims, to say nothing of other claims under bond and lease. In October, 1894, they began to drive a tunnel, 8 feet by 8 feet, the work being started at both ends. It was completed in March, 1896, the total length being 4,508 feet, and the total cost being more than $60,000. Not less than 64,000 pounds of dynamite were used for blasting, and more than 300,000 cubic feet of rock were taken out. The greatest depth is 900 feet. By means of the tunnel 200 tons of ore and waste are now daily taken out with the minimum of power, and the various properties are drained, by natural gravity, to the extent of 400 gallons per minute, the estimated saving in operating expenses being from 50 to 60 per cent.

THE ROAD TO A TUNNEL.

As a further illustration of the mineral wealth of the general district in which the Lamartine mine is located, it may be stated that since 1859 a little strip of country, 4 miles long by 2½ miles wide, around Central City, Gilpin county, has produced over $80,000,000 of mineral, mostly gold, while the adjoining section of Clear Creek county around Idaho Springs has been a proportionate producer. Around Central City there are ten mines which have passed the million-dollar mark in their production. There are five to ten shafts reaching a depth of from 1,200 to 2,200 feet, and perhaps twenty

mines ranging from 700 to 1,200 feet in depth, with many of lesser depth. In consequence of the excessive cost of pumping and hoisting, the working of some of these mines has been temporarily abandoned. In view of the fact that Idaho Springs on the main stream of Clear Creek, while less than four miles in an air line from Central City, is about 1,100 feet lower in altitude, it was simultaneously determined by various parties to run long tunnels, at a slight up grade, practically from the line of railroad below and above Idaho Springs, in the direction of the rich mines, and, by tapping them from below, not only to drain them automatically, but to take out the ore by natural gravity to the railroad tracks.

The first of these is the Newhouse tunnel, commenced in January,



AN UNDERGROUND JUNCTION IN A SIDE TUNNEL.

1894, representing British capital entirely. It enters the mountain from the railroad a short distance below Idaho Springs. Its total length will be 4½ miles, and several years will be required for its completion. The estimated cost is $2,000,000, the cost per foot so far being $35. The greatest depth of the tunnel is 3,000 feet, and at its proposed terminus near Central City its depth will be considerable. It is 12 feet wide by 12 feet high, is already in over one mile, and is being rapidly pushed by means of double shifts of men and air-drills operated by powerful compressors.

The second enterprise, the United States tunnel, is being constructed by capital from Belgium. It starts about half a mile above Idaho Springs, and is to run about 3½ miles, but as yet only a comparatively short length has been driven.

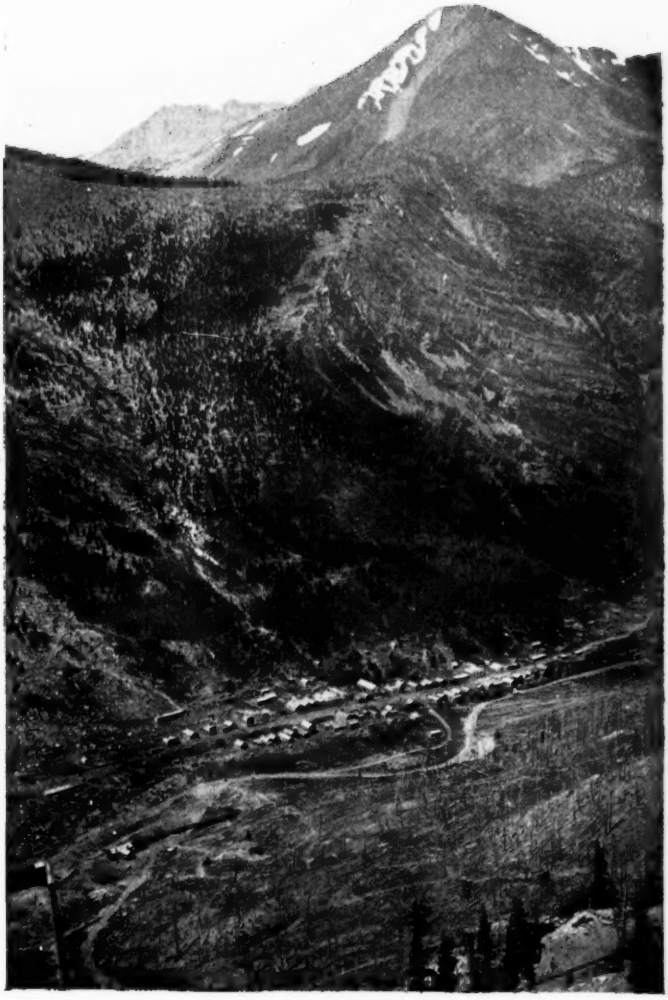
The third enterprise is the Pennsylvania tunnel, being driven by private Philadelphia capitalists, primarily to tap their own properties, consisting of one hundred and seventy mining claims, of which one hundred and thirty are patented, having an aggregate area of about 1¾ square miles. It starts about 3½ miles above Idaho Springs. It is already in 2,000 feet, and, when completed, will be 2½ miles long. At two miles from the mouth it will be 1,800 feet below the surface. It is about 8 feet by 8 feet in size, and is expected to cost about $250,000.

The fourth enterprise is the Knickerbocker tunnel, which begins three miles from Idaho Springs. It is 7 feet by 5 feet, and is already in 550 feet, and its total length will be 3,800 feet, the greatest depth being 1,200 feet. It represents Colorado, Missouri, and Illinois capital.

Briefly stated, these four tunnels will undermine, at a depth of from 1,000 to 3,000 feet, a mountain chain or group about four miles in diameter, traversed by an extraordinary number of parallel true-fissure gold- and silver-bearing veins, the richness of many of which has been satisfactorily proved by shafts from the upper surface, while the existence and richness of others are fairly assumed.

There are several important tunnels around Georgetown, Clear Creek county, known as the Burleigh, Ashby, Marshall, Diamond, and Victoria tunnels, each driven by mine-owners to develop their own properties, as was done at the Lamartine mine.

From an area a few miles square around Leadville, Lake county, from 1859 to the present time, gold, silver, and lead to the extent of $200,000,000 have been produced, and there are now several tunnel enterprises being pushed in that district, including the Yak tunnel and Agwalt tunnel. The Yak tunnel is already in 6,000 feet, but its total length will be 12,000 feet, or more than two miles, as it is to tap the



A COLORADO MINING CAMP.

Leadville gold belt; the estimated cost is $300,000, the money being furnished by a syndicate of Colorado capitalists.

There are also important tunnels around Rico, Dolores county, Creede, Mineral county, and elsewhere in Colorado, detailed mention of which is not necessary.

The foregoing illustrates very clearly the fact that the days of "wild cat" mining are, or ought to be, over, and that the days of intelligent mining are here, calling for a combination of practical experience, competent and economical management, professional skill, and ample capital. Conducted on the business principles now possible (such as are recognized as necessary in any other business), and looking for profits solely to ore shipments and not to stock manipulations and the gold and silver in other people's pockets, there is no more legitimate or profitable industry than mining. On such a basis millions of dollars can be safely and profitably invested in well-considered mining enterprises in the Rocky Mountain region extending from the British line to the northern border of Mexico.

THE RELATIONS OF STREET-CLEANING TO GOOD PAVING.

By Geo. E. Waring, Jr.

THERE is a very clear and close relation between the character of the road surface and the work of keeping it clean. It is possible to maintain a good state of cleanliness with any surface. Even the old cobble pavement of earlier New York, swept with a besom of birch twigs worked almost vertically over it, was, in a few streets like Bond street of fifty years ago, kept in excellent condition. While the earth between the stones was plainly to be seen, it was free from foreign accumulations, and the stones themselves were as bright as the shingle on a beach. In Turin—one of the cleanest cities of the world—a large part of the pavement is of small cobble-stones, hardly larger than a goose egg. It is kept in beautiful condition with the long broom of *ramalia* twigs, moved over it with a horizontal sweep. For all that, any form of cobble pavement is the last thing that a street-cleaner would suggest as desirable.

The permissible pavements, from his point of view,—those which are suitable for the heavy traffic of a great city, and which are at the same time kept clean at reasonable cost,—are: asphalt, wood, stone-block, and brick. Concerning the latter I have no practical knowledge, but it must be easy to sweep. Concerning all of them it is to be understood that they must be good of their kind.

It seems to me that *good* asphalt is, all things considered, and on moderate grades, the best of all pavements; second-rate asphalt is, however, one of the least desirable. I saw, occasionally during twenty years, the asphalt about the Bank of England, which was capitally well laid, and which was never allowed to fall into the least disrepair. It always looked new, and it must have had its beginnings of failure repaired almost nightly. It carried the heaviest and most constant traffic from morning till night,—heavier than any that we know here. It was always clean, though the only care it received during the day was the work of the red-coated boys, who flew in and out among the horses like sprites, brushing and scooping up the droppings as they fell. At night it was drenched with water and squeegeed and swept, until all trace of the day's wear was obliterated. I doubt if either wood or stone would have stood the test so well, or would have required so little interruption to traffic for necessary repairs. The fine wood-paved streets of London are not so well kept,

though they often look cleaner, because wood does not show stains as asphalt does.

We have little asphalt pavement in New York that is either as good, or as well kept, as that described above, but we have much that is very good, and I incline to think this material better than any other available for our use, always assuming that it be kept in perfect repair. It is easy to maintain such pavement in a very fair state of cleanliness, by the use of an iron scraper-scoop for streets of moderate traffic, and of the scraper and broom for those more frequented.

Unless the surface is very uniform, the sweeping machine is not thorough in its work, even on asphalt, because it fills depressions with dirt, instead of cleaning them out. I have yet to see conditions where machine-sweeping is either as economical or as effective as hand-sweeping. It does very well for rough night-work and as a preparation, but really clean sweeping needs daylight and the attention of a faithful hand, under watchful supervision.

Asphalt has one quality that makes a "fair state of cleanliness" insufficient. From some cause, which even experts are not clear in explaining, it becomes so slimy and slippery when it begins to get moist under a light rain or a heavy mist that it is unsafe for driving—especially for the hauling of heavy loads—and for the bicycle. With a drenching rain this condition soon passes, and thoroughly wet, clean asphalt is safe for any use. If slime is allowed to accumulate, so as to form a film of mud, an asphalt street is a terror to all who drive or wheel; only sanding will make it safe. More or less often —every night in the case of the heaviest traffic—the surface should be drenched, and every trace of organic matter, and of detritus, should be washed off; and the scraper-scoop and the broom should be kept going during the day, removing all extraneous matter as fast as it accumulates. With such care, under proper administration, and with nightly attention to imperfections, asphalt is the most economical and the most practical of all pavements, and the most easily kept clean.

It is a great advantage that it is so entirely non-absorbent. All its filth is on the surface, where it can be got at, and all the water of rains and of the sprinkling-cart can be made to tell for its full value. If the street is kept free of litter, its washings can be run into the sewer without inconvenience; and what has to be gathered up and removed by carts is only what the street receives from its use,—legitimate or otherwise. There is no admixture of earth from below, such as we have in the case of most of our stone-block pavement. As a matter of fact, a perceptible portion of Manhattan island now works

up through the crevices of our stone pavements, and is daily sent out to Sandy Hook lightship, at a cost to the city.

Under icy conditions, asphalt must be sanded, or those who use it must take their chances. In this case, as in that of sliminess, the fact is emphasized that asphalt is as bad, when left to itself, as it is good when properly taken care of. Its use entails constant care, but the care is well rewarded. No other outlay brings so good a return.

With the exception of a single block,—to be referred to hereafter,—we have no wood pavement in this city, and I know of no really good wood pavement in this country. In London, in Paris, and in other towns abroad, this material is used with great success as a top finish for a thoroughly-graded and well-concreted foundation. The foundation is the real pavement. The wood is, so to speak, a mere carpeting above it, to deaden sound and to take the wear. When the work is well done,—as, for example, in a case that I examined recently in Birmingham,—the wood may be worn away nearly to its full depth without in any wise disturbing the concrete on which it is laid. I saw an old wood covering being taken up, parts of which were not more than three-quarters of an inch deep. The foundation was absolutely unaffected, and the work of relaying fresh blocks was rapid and inexpensive.

Such pavement is even more agreeable than asphalt to drive over, and the sound of the horses' tread is deadened,—a great advantage. The material wears more or less well, according to the character of the work and the amount of the traffic, but always, under good conditions, well enough to be economical. Such pavements, except when quite new, seem to be more slippery than clean asphalt, and, as they wear, they become uneven. They have the disadvantage of absorbing a good deal of water, and, as ordinarily laid, they are not uniform in surface, the edges of the blocks becoming worn away so as to produce a somewhat ridgy condition. I found it the custom in England to sand these pavements regularly. Even in dry weather, they are sometimes sprinkled with sand once a day, and in wet weather twice a day, or oftener. This adds to the cost and difficulty of keeping them clean, and it is impossible to keep them as clean as asphalt, though they may look cleaner. This is an opinion formed from observation only, not from experience.

The one block of wood pavement in New York referred to above is in Twentieth street, between Fifth avenue and Broadway, where the material used is a variety of Australian Eucalyptus, called "Karri." This pavement makes more noise under the horses' feet than those of softer wood, and it is, in other ways, very like asphalt. It is said to wear better, and to be somewhat freer from the slippery condition under

slight sliming, but it is evident from its use that it will require a certain amount of sanding to make it entirely satisfactory. It is as easily cleaned as any material in use in New York city.

Of stone-block pavement we have a very large amount, and a great variety of form and quality,—most of it thoroughly bad. This pavement has the great objection—even in its best development, as in Vienna—of being very noisy. The best in New York is not nearly as good as the ordinary Viennese work, and it is more difficult to keep clean. The usual stone-block pavement of New York is as good as the best for a very short time after it is laid, but, with its imperfect foundation and constant tearing-up and relaying in order to get access to the various underground pipes, it soon becomes a "humplety-bumplety" affair, difficult, and sometimes dangerous, to drive over, very unpleasant and difficult for wheeling, and wretchedly bad for cleaning. Under heavy traffic any stone-block pavement may be made to look cleaner, as seen from the sidewalk, than asphalt, but nearer examination discloses the fact that much dirt which ought to be swept up and carried away is simply lodged and packed in the crevices between the stones.

A very good example of a generally good stone-block pavement is that on Fourth avenue, the Bowery, and Park row between Seventeenth street and the post-office. It is not very difficult, with thorough hand-sweeping and a frequent collection of droppings, to maintain here a very creditable appearance; and, when we succeed in making the sweepers drive their brooms lengthwise of the stones, so as to brush well down into the intervening crevices, its condition is, on the whole, and most of the time, very good. Under the traffic that is usual on these streets, it would be difficult to make asphalt, though really much cleaner, look as clean as this stone pavement does.

All of our pavements would be much better, if it were possible to avoid the frequent tearing-up to which they are subjected; but, with our system of water- and gas-pipes, sewers, and their various house connections, it seems hopeless to attempt this.

Whatever the character of the pavement, we have one condition that adds enormously to the labor and cost of even tolerable cleaning, —namely, the bungling construction of our street-railroad tracks. These seem to have been laid, save on the cable lines and a few others, with regard only to the convenience of the railroad companies, and nearly all our street-car lines make the maintenance of a good roadway impracticable, and the work of cleaning difficult and unduly costly. We are reforming in this regard, as in many others. The tracks of the Broadway cable road and its extensions, and those of the Third avenue cable road, are a great improvement on anything we had before,

while the track now being laid on First avenue is decidedly better than these.

But the old tracks of most of the horse-car lines are a terror to all who use the streets for driving or for wheeling. The worst form is the "centre-bearing" rail, which is a square ridge of iron, with a deep, wheel-wrenching channel on each side. These depressions are ideal harbors of dirt. Many of the very good asphalt streets, in the East Side tenement quarter, have two of these double channels, bordered with rows of granite blocks. But for this condition, these streets could be kept as clean as a floor,—as Lexington avenue, with asphalt close up to the rail, is kept now. It would pay the city well, if only in the reduced cost of street-cleaning, to reconstruct these tracks at its own expense,—laying a properly designed rail directly in the asphalt.

It is notorious that the cost of street-cleaning in New York is inordinately high. The cost, for sweeping alone, in 1896 will run up to about $1,155,000. With perfect asphalt pavement and the best form of car-track rail, this could be reduced by fully half a million dollars, and much better work could be done for the smaller amount. This shows that the relation between paving and cleaning is so important that all paving work should be carried out with full consideration of the requirements of the best methods of cleaning.

ELECTRIC CENTRAL STATIONS VERSUS ISOLATED PLANTS.

By R. S. Hale.

THE article entitled "Are Electric Central Stations Doomed?" which appeared in a recent number of THE ENGINEERING MAGAZINE, opens up so interesting a field of study, and leads to results so unexpected both in the light of theory and of practical experience, that I have been interested to go a little deeper into the questions raised, in order to see if the author's assumptions and conclusions depended on facts, or were merely theoretical. My work for the last three years has been chiefly in the line of analyzing records and tests, in general engineering, but chiefly in electric station work, for the Boston Edison Co., in order to find out why theoretical and practical results should be so different. It is thought that a like practical analysis of the comparative costs of electric current in isolated plants and in central stations might, even if perhaps inconclusive, be of interest to the readers of the paper referred to and to others.

The writer starts by assuming that he has obtained permission to supply electric current to the owner of each building in a square block of fifty houses. As a matter of fact, the only practical case is a hotel or large building using current equal to fifty houses, since a station for fifty separate houses would begin by supplying three or four, and would have to run ruinously underloaded for several years. If, however, the fifty houses are owned by the same landlord, the latter can compel the tenants to take electric light and no other, and to pay whatever price he may set. This is also the case in a hotel or office-building, except that here the price goes to increase the rent, and does not appear as a separate charge for electric light.

The model block station would, it is assumed, be called on to supply 2,500 lamp hours per day. This the writer works out to equal 137 k. w. h., and to need the generation of 186½ k. w. h. There is apparently one arithmetical mistake here, and probably more than one, for a moment later he works out the cost as $4.81 per day, which he states to be 2.31 cents per k. w. h., whereas $4.81 ÷ 186½ = 2.58 cents, and $4.81 ÷ 137 = 3.51 cents.

The arithmetical deductions from the figures will not, therefore, be discussed at this moment. We may, however, look over the figures on which the deductions are based, and see on what facts they rest. He assumes that, by means of utilizing part of the exhaust steam

for heating, the coal consumption can be brought down to five pounds of coal per horse power per hour. Five pounds of coal per horse power per hour without such an allowance is an absurdly low figure for a plant of the size under discussion. Such a plant would have single-expansion, non-condensing engines of small size. There are no exact records of the output and coal consumption of a plant of the size in practice, the only figures we have being for short runs; and such short tests, though probably correct enough in themselves, are notoriously inaccurate as a basis for figuring actual results.

Lbs. Coal.	
K.W. hour.	E. H. P. hour.
6.1	4.5
8.1	6.
9.2	6.9
10.5	7.8
10.9	9.1
14.5	10.8
15.6	11.6
16.1	12.
20.4	15.2
17.9	13.3
17.9	13.3
17.5	13.
18.5	13.8
18.8	14.
20.4	15.2
18.8	14.
19.6	14.6
21.3	15.9
27.	20.1
23.8	17.7
23.8	17.7
23.8	17.7
13.7	10.2
12.5	9.3
11.7	9.5
10.6	8.9
9.	6.7
	328.8
average	12.2

We may, however, take the actual results in a large number of central stations as recorded in the report of the committee on data of the National Electric Light Association (*Electrical Engineer*, May 20, 1896), where we find the following reports on engines of the type used in isolated plants, although in stations of rather larger size. Even then the majority of these reports are based on only a portion of the years run, and so probably make a showing better than the actual results; whence it follows that the small block station, with two, or, at most, three, engines, would, in actual practice, give rather worse results. Still, taking the actual figures with no such allowance, we have 12.2 pounds of coal per horse power as an average, some of which can, in an isolated plant, be charged to heating. During April, May, June, July, August, and September we need no heat. During the other months we save nearly all the steam used, except during the time of heavy load; but the heavy load, unfortunately, comes from 4 to 6 P. M.,—that is, just the time when the offices are closing up and the demand for steam heat is least. Still, during the winter months the average use of the light is the greatest, and it will be fair to assume that enough is saved during the six winter months to bring the average coal per horse power for electricity down to one-half the total coal. That would make 6.1 pounds of coal as the average per horse-power hour chargeable to electricity, without considering the extra cost due to the fact that an isolated plant is smaller and worse managed than a central station using similar engines.

The figure assumed in the article under discussion was 5 pounds per horse-power hour, allowing for all savings. The cost of labor is

taken at $2.50 per day. This is about as low in proportion to the actual cost as is the 5 pounds of coal per horse-power hour, taken above. A responsible engineer who can take charge of the plant, run the engines, take care of dynamos, and look after storage batteries, and yet is satisfied with $2.50 a day, is hard to find. If storage batteries are not used, then, in order to give the same quality of service as that supplied by the central station, two engineers must be on duty twelve hours a day each. In addition, though the labor of the fireman during the winter is, of course, chargeable against steam heat, yet during the summer his wages must be an extra expense.

The cost of water is referred to briefly. This is a very slight tax on the isolated plant in a few cities in which the charge is so much per boiler per year, since the number of boilers is the same, whether they be used for heating or lighting. If, however, the water be sold by meter, then the water for all the steam made must be charged against lighting, whether it be used for steam heat or not. The reason for this is that, if the boiler be used for heating only, the condensed steam can be trapped back to the boiler and used over. If the steam be first passed through an engine cylinder, the oil makes all the condensed steam in the heating system unfit to use in the boiler, and fresh water must be taken from the city mains and paid for.

There are, however, numerous expenses that are incurred by the central station as part of its cost for the production of current, besides those that the writer now under review has considered as the sum total of the isolated plant costs. Let us see if, as a matter of fact, coal, labor of engineer, oil and waste, and water, make up the sum total of the costs. Taking up, first, a charge made in all central stations under one name or another,—*viz.*, management or superintendence,—let us see if this is not as real a part of the cost of an isolated plant as it is of the cost of the central station.

Recently a gentleman who was considering the purchase of an isolated plant for a building in which he was interested said that his isolated plant would cost him nothing for superintendence, because he would hire a good engineer and depend on him.

"I do not believe," he added, "that I myself would spend more than an hour a week, in all, on my isolated plant." He was making, possibly, $6,000 a year, but did not stop to reflect that, at this rate, his hour a week amounted to $2 a week, or $100 a year.

The cost of clerks, accountants, office-expenses, etc., is an item very similar to management. In the isolated plant all this is charged, not against the electric light and power, but against the general expense of the business; still, it is really as much a part of the cost of electric light as is the management. A frequent assumption is that

the bookkeeper or some other clerk attends to the electric-light matters. But then, suppose the general business improves a trifle, so that all the clerks are fully occupied on general business. Then the isolated plant makes another clerk necessary.

Take another example of an account not generally charged against isolated plants,—*viz.*, taxes. If the building stands in the name of a private individual, the isolated plant sometimes escapes taxation ; but if in the name of a corporation, it must stand its share.

But, though enough has been said to show that the method pursued in the article is unreliable and inexact for the purpose in hand, yet it is not to be thought that it is proposed here to recommend any change in the account-keeping of those owners who are still running isolated plants. The object of keeping accounts is merely to keep track of expenditures in order to avoid waste of money and to keep the business within proper bounds.

Hence, unless any account in the ledger or any entry on an account saves in the end more than it costs to keep it, it is better not to keep it as a separate item. Now, this is just the case with a-half or two-thirds of the true expense of an isolated plant. To be theoretically exact, the isolated plant should be charged with its share of the taxes, insurance, general expense, office-expense, janitor's pay, etc., but, practically, it would cost more to divide these up among different accounts than could possibly be saved from year to year ; so that the wisest way for the manager of an isolated plant is to charge against the isolated plant only the obvious expenses, and to compare these from year to year with the costs for the previous year. His accounts will not show the true costs, but the loss by the error will be less than the cost of making the subdivisions. When, however, the central station is in a position to supply current, the case is entirely changed, since there is now a chance to save all the indirect expense and bother of the isolated plant as well as the direct expense that appears on the accounts, and these indirect expenses must be added to get the true measure of the amount that can be paid for central-station current.

It is an unfortunate fact that the owner of a building must make up his mind for himself which of the two costs is the lesser, since, practically, every one competent to judge is interested on one side or the other. On the one hand, it is to the advantage of the central-station to sell the current at once rather than to hunt for other customers, and, on the other hand, the boiler-maker, the engine-maker, etc., even to the consulting engineer, get larger profits out of fifty small isolated plants than they would out of one central station.

All that this paper can do, therefore, is to show a way of determining the question which, though it would be a very impractical

way so far as account-keeping from year to year is concerned, is yet the only practical method of computing the costs when the question arises whether a new isolated plant shall be put in or an old one renewed. The method is as follows:

Determine what it would actually cost with the isolated plant for each item, including all expenses.

Determine what it would cost with the central station for each item, including all expenses (profits or dividends to be considered as an expense).

Then that which is, on the whole, the cheaper, paying due regard to quality, is the better.

First, let us determine the proportionate size of the two plants, assuming a certain amount of current. The isolated plant needs one, or, at most, two engines to supply its load, and must have, at least, one engine as reserve, making a 50 per cent. or 100 per cent. reserve. The central station has from twenty to fifty engines, and can get along with from four to ten as reserve, or 20 per cent. The central station has, however, to waste about 10 per cent. of its power in transmitting the current, making additional machinery necessary. Finally, the central station is able to double up at times on the use of its machinery, since all the light and power in different parts of a city will not be in use at the same time, while the isolated plant must be prepared to run a much larger proportion of the light and power connected to it. Taking all these considerations together, the central station needs, in proportion to the current used, only about two-thirds of that amount of machinery which the isolated plant needs.

The boilers for the isolated plant cost nothing beyond the expense of making them fit for high-pressure steam, as they must in any case be provided for steam heat.

Neither are the underground or overhead wires needed at all for the isolated plant (unless, of course, it supplies several buildings).

The cost or rent of land is much greater for the isolated plant, since the land must be located where the building is, and not only takes up room that could be used for store-room or rented, but also, on account of the heat and danger from high-pressure steam, and of the tremor of the engine, lowers the rental value of the building. *

* The writer of the former article assumed that the cost of land, or, what comes to the same thing, the rent, would be negligible. I, therefore, took occasion to ask the manager of one of the large real-estate trusts in Boston what rent he would charge me for space enough for isolated plants in some of the buildings. He very kindly went over the matter with me, and we found that, in a building corresponding in location to the Boston Edison Station, the rent for enough space for a small isolated plant would come to about $100 a year, and this was the lowest rate in the list he gave me. In locations in the central portion of the city the rent was about $750 for the same amount of space. In addition to these charges, he said he should have to require the isolated plant to be built so as to not interfere with other tenants, and in some buildings he could not allow an isolated plant in any case.

The minor items of capital account, such as cash kept on hand for payment of operatives, bills receivable, fuel on hand, supplies on hand, etc., are all as large for an isolated plant in proportion to its size as for a central station. At first sight, perhaps, items like "accounts receivable" are not part of the capital account of an isolated plant. It takes, however, only a moment's reflection to see that, if the light is included in the rent, the holding back of a rent bill by a tenant inflicts exactly the same proportional expense on the isolated plant that the holding back of a light bill inflicts on a central station. The same principle applies to the rest of the capital charges.

Now, the costs of the electric lines and conductors, and of the boilers, make up in all about forty per cent. of the capital of the central station, nearly all of which is saved by the isolated plant. An isolated plant must provide the capital for the other items in proportion to its size, and this is fifty per cent. more in proportion to the current used, on account of the extra fifty per cent. of machinery needed by the isolated plant, as shown above. One hundred and fifty per cent. of 60 per cent. is 90 per cent., leaving the isolated plant apparently 10 per cent. cheaper in first cost than the central station. Against this, however, must be set the fact that the central station is a big undertaking, and the isolated plant a little one, and that buying in large quantities is cheaper than buying in small.

The first cost of the isolated plant is then more than 90 per cent. of that of the central station. The fixed charges are:

(1) *Depreciation.*—This will be greater on the isolated plant, since it will not have as skilled management as the central station.

(2) *Taxes.*—These will be less for the isolated plant, provided it is in a private name. If it stands in the name of a corporation, the taxes will be the same.

(3) *Insurance.*—This will be the same, on the plants themselves. The isolated plant, however, will involve a higher rate of insurance on the building containing it.

(4) *Interest.*—The true interest is, of course, the same in both, this being the interest that is paid merely for the use of the money. The interest that represents profit or dividends is also the same in both cases, since the owner wants to make as much profit out of the money he invests in an isolated plant as he would have made on the same money if he had invested it in some other way. The interest due to risk is greater for the isolated plant, for there is greater risk of loss when money is invested in an electric plant that is to be owned and managed by a non-expert than when it is invested in an established business, like central-station lighting.

Taking all in all, then, we find that, though the first cost of the

isolated plant may be ten per cent. less, all included, than the cost of the central station and its street conductors, yet, since in the isolated plant nearly all the fixed charges are a larger percentage of the first cost, it is fair to conclude that the final expenses for the above items are as much for the isolated plant as for the central station.

It is to be noted that none of the above items are usually charged against the cost of electricity when the latter is supplied from an isolated plant. The owner of the isolated plant can make no saving from year to year by dividing up these items on his accounts, so that the bother of splitting up the insurance bill, the interest, etc., is not warranted, until there is a chance to reduce those items by taking street current, instead of putting in a new isolated plant.

General expense, office-expense, stationery, management, etc.—These items are greater for the isolated plant, except for the cost of selling, which will be spoken of below. No merchant would look out for and manage his neighbor's isolated plant without expecting a very reasonable compensation for the time and trouble to himself and his clerks. We may, if we choose, look at it in another way. If the owner has an isolated plant in one building and then buys the adjacent building, does he find it cheaper to put in another isolated plant, or to run the wires across? Yet, if the saving in running one isolated plant instead of two isolated plants is not due to the saving in cost of superintendence and management, where does it come in?

Selling.—It is obvious that the true cost of managing the isolated plants is greater than the cost of managing the central stations, even if no charge for management be made against the isolated plants on the books. The cost of selling electricity is not apparently a charge on the isolated plant. It is, however, really a charge in one sense, as follows. The central station always has before it the possibility that its customers may drop off, and so it must keep in with them, which costs money. The customers, therefore, always have the privilege of reducing the amount of current they use if the building should not be fully occupied, or of stopping altogether if business should be bad. This is worth something to the customer, while, on the other hand, the owner of the isolated plant binds himself to pay the interest, taxes, insurance, etc., on his plant, until it is worn out, whether the building is full or not. If the customer of the central station is willing to forego his privilege of change, and to make a contract for a term of years, he can frequently get a reduction in price corresponding to the cost of advertising and selling.

Repairs.—The cost is greater for the isolated plant, since the management is not so skilled. It should be noted, however, that the records of even a number of isolated plants will not show this, for the

following reason. Part of the repairs are due to the wearing out of minor parts of the machinery, and part are due to smash-ups. Out of the fifty engines at the central station, perhaps one will break down every other year, and the cost will be charged to repairs. Out of the engines of fifty isolated plants, one will break down every year. This, however, will, in the majority of cases, lead either to giving up the isolated plant, or to putting in an improved engine or dynamo, the whole cost of which will be charged to construction, and not to repairs.

Lamps.—The cost of lamps will be less to the central station than to the isolated plant. Beside the fact that the central station can buy cheaper in large quantities, it can afford to test each lot of lamps. Of course, if, as in some cities, the central station does not supply lamps free, then the cost is no more (and no less) whether the current is made in the isolated plant or the central station.

Street Repairs.—The cost of repairs on the street conductors is zero for the isolated plant, but the cost of repairs to underground street conductors is less than 1 per cent. on the cost in actual practice, and generally averages less than ½ per cent.

Meter Department.—The cost of the meter department of the central station, for measuring the supply to the customer, is entirely saved by the isolated plant. The meter department, however, of most electric companies more than pays for itself by allowing the customers to save light when the customers care little about it.

Labor.—The cost of labor in the boiler room is greater for the central station, since the isolated plant can charge its boiler-room labor during the winter to heating. The engine-room labor and the labor on electrical apparatus is, however, greater for the isolated plant, and this portion of the labor is, from actual experience of the electric companies, two-thirds of the whole cost of labor of producing electric current. When it is remembered that the amount of labor required depends more on the size of the plant than on the number of hours it is run, and that the isolated plant must be fifty per cent. bigger than the central station to supply the same amount of light, it is seen that, in fact, all the boiler-room labor in an isolated plant might be charged to heating without bringing the isolated-plant cost of labor below the central-station cost for the same amount of light. Generally, if the boilers do not take up a fireman's whole time, he can spend the spare portion in doing odd repairs and cleaning in the basement, but sometimes in a heating plant the fireman claims that he would be willing to run an engine also at no increase, or a small increase, in his wages. As a matter of fact, however, after the isolated plant is put in, the fireman-engineer will come to the owners and explain that, though he can actually run the plant alone, it will be economy to give him an assist-

ant engineer or fireman. Thus, in the end, the cost of labor will be found to be as above stated.

Coal.—The average amount of coal per horse power was found to be 12.2 in the central stations using the type of machinery that is used in the isolated plant. The isolated plants would, of course, be more expensive by reason of their smaller size and since the engines will be more usually underloaded. Against this must be set the fact that about one-half of the year's coal can be charged to heating, bringing the net pounds of coal per horse-power hour down to 6.1 pounds. The cost of coal per horse power is not quite as low, since the central station buys its coal in large quantities at a cheaper rate, and is generally situated either on a railroad track, or on the water front, while the isolated plant must buy in small quantities, and must pay forty to fifty cents per ton for carting. Then, too, the central station can often burn a cheaper grade of fuel than is practicable for the isolated plant. In spite of these advantages, the isolated plant has a considerable advantage, so long as the same type of engines is used in both plants. The isolated plant is limited, however, to one type of engines,—*viz.*, single-expansion non-condensing, none other having been found practicable in small plants. The central station can use triple-expansion condensing engines, which have, by actual tests, given a horse power for 1 ¼ pounds of coal per horse-power hour, or only one-tenth the average coal per horse power for plants that are even more economical than the average isolated plant. This is, of course, not a fair comparison, though as fair as the method practised by some engineers. The actual central-station records taken from the report from which the figures for the isolated-plant type of engine were taken show an average of 3.7 pounds of coal per horse-power hour for the triple-expansion condensing engines, and less than five pounds per horse-power hour for the compound condensing engines, against 12.2 pounds per horse-power hour for the isolated-plant type of engine. Hence we see, after allowing for the higher price paid per ton by the isolated plant, more than one half the coal might be charged to steam heat and still leave the coal bill greater than that of the central station in proportion to the current supplied.

Oil, Waste, and Miscellaneous Supplies.—These are, in general, proportional to the size of the plant, and are, therefore, in proportion to the current, much larger for the isolated plant than for the central stations.

Water.—The cost of water is the final item to be considered. If the water rate is so much per boiler per year, irrespective of the amount used, the advantage is much in favor of the isolated plant, but, if the charge is proportional to the amount consumed, the cost

is, in general, proportional to the total coal bill, and *all* the water must be charged against the isolated plant, for the reason that the condensed steam cannot be safely put back into the boilers, on account of the oil in it. In addition, the central station, by reason of using large quantities, generally gets a lower rate, so that the cost for the isolated plant is more than double that for the central station.

Summarizing, then, we find that the isolated plant is very seldom charged with any part of its share of the taxes, insurance, depreciation, or interest, and that large portions of the management, accounting, repairs, labor, and miscellaneous expense of an isolated plant are also charged against other accounts.

We find, however, that the first cost of the isolated plant is actually less than that of the central station only in the items of boilers and electric street conductors, the isolated plant being more expensive in first cost for engines, dynamos, real estate, and every other item of capital account.

We find that the isolated plant costs less to operate than the central station only in the items of boiler-room wages and, possibly, water, advertising, metering the current, and taxes, the cost being greater for management, accounting, repairs, labor on the engines and electrical apparatus, coal, miscellaneous supplies, insurance, interest, and depreciation.

We find that a comparison of the real expenses of an isolated plant with those of a central station shows that not only is the total first cost practically as much as for the central station in proportion to the current supplied, but that, if all the expenses are included, the cost of operation of an isolated plant is far greater than that of a central station.

The only possible conclusion, then, is that it is cheaper for the real-estate man, the hotel-keeper, or the dry goods merchant, to devote his brains and intelligence to making money in his own field, where he is an expert, than to waste his time on a small electric plant. No matter how skilfully he may run his isolated plant, he will lose money, or—which comes to the same thing—not make as much money as he would have made had he employed his time, his capital, and his brains where they are most effective.

And, finally, we see that the central station is not doomed, but that, when the true comparative costs are accurately known by the owners of the buildings, an isolated plant for electric lighting will be as much of a curiosity as an isolated plant for gas lighting would be to-day.

PIONEER LOCOMOTIVES IN ENGLAND AND AMERICA.

By Alfred Mathews.

WHILE the actual beginning of steam railroad transportation in this country was in the early thirties, and the trial of the first practical locomotive that ever turned a wheel upon a track in America was made on August 9, 1829, in the woods of northeastern Pennsylvania, at Honesdale, under the auspices of the Delaware & Hudson Canal Company, there were numerous foreshadowing experiments, both in England and America, many years earlier.

Many minds were occupied with the alluring, but elusive, locomotive idea from the time when steam was first demonstrated a success in the operation of the stationary engine. In America the bee buzzed early and persistently in the bonnet of Oliver Evans. Cugnot, of France, brought out a steam carriage in 1771, and Evans is known to have been at work upon the same idea in 1772. The Frenchman patented his invention in 1784, and in 1786 the American, again two years later than his Gallic rival, applied to the Pennsylvania council for a patent upon his.

A few years later Evans's locomotive—for such it was, though not a *railroad* locomotive—was given a trial, and this was undoubtedly the first steam carriage, of any kind whatever, run in America. It was a strange, amphibious monster, designed to travel on land or water, and less a success on the former than on the latter.

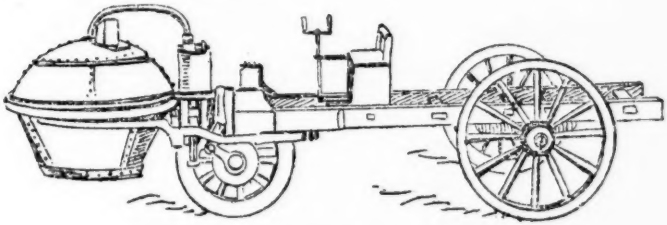
Tramways—with tracks of stone, at first, and later of iron—originally came into use in British coal mines, and it was by them that the idea of the railroad was suggested, which, being united with that of the traveling steam engine, made the locomotive idea practicable.

It was in 1802 that Trevithick and Vivian, two Cornish engineers, brought out a steam carriage designed for common roads, or, by a modification of the lines of the wheels, for railways. After repeated improvements, it was placed on the Merthyr-Tydvil Railway in South Wales in 1805, and was a practical success in drawing coal cars.

This was the first locomotive ever run on rails, and for this and several other reasons it was perhaps the most remarkable example in the history of locomotives. The body of the carriage was in close imitation of the old English stage-coach. It was high-pressure and noncondensing, and had several features that were then new but have been retained in the light of later experience. The main item of interest

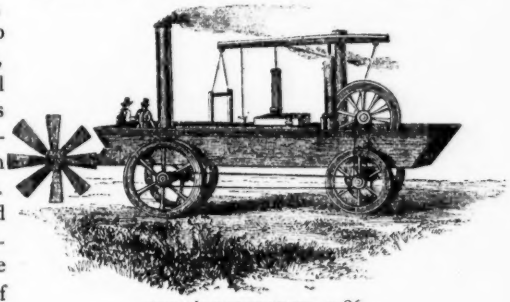
in regard to this steam-power Welsh wagon, however, was that it practically demonstrated the utility of the railway locomotive.

Various productions followed, but, with them all, not until twenty-five years after the time of the invention of the *track* locomotive (Trevithick and Vivian's) was the railway used for any other purpose than that of coal-transportation.



THE FIRST STEAM CARRIAGE. DEVISED BY CUGNOT, 1771.
From an old cut in *The Engineer*, London.

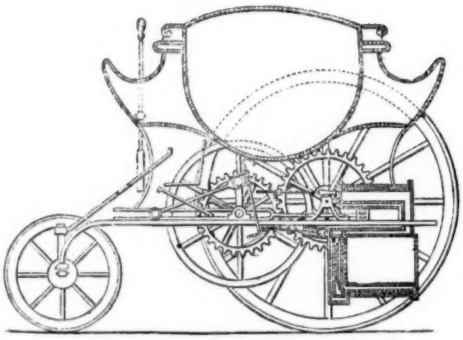
Blenkinsop's "Lord Wellington," made in 1811, for a colliery near Leeds, was notable as having as its means of propulsion a cog-wheel fitting into a rack on one side of the track, the idea being that the tractional adherence of the driving-wheels to the rail was not sufficient. Hedley's "Puffing Billy" of 1813 was another moderately successful locomotive, and it is curious to note that it was used, more or less, until 1862, when it was given an honorable retirement in the British patent-office museum.



EVANS'S LOCOMOTIVE, 1786.

One of the odd ideas of early locomotive building was the supposed necessity of vertical cylinders, which nearly all the mechanicians of the time regarded as of value in pressing the wheels down upon the track, an idea quite analogous to that of lifting one's self by one's boot-straps.

George Stephenson retained this idea in an engine which he built in company with Dodd, in 1815, and in several later ones; indeed, it was modified in the famous "Rocket" only so far as to tilt the cylinders at an angle of about forty-five degrees.

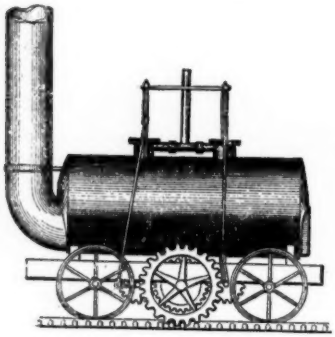


TREVITHICK AND VIVIAN'S LOCOMOTIVE, THE "MERTHYR-TYDVIL," 1805.

What has been regarded by some as the birth-day of the railway locomotive occurred on September 27, 1825, with Stephenson as the father of the event. The Stockton & Darlington railway had been built, and, through his persistent importunities, laid with iron, instead of wooden, rails. It had been intended merely for horse-draught, but the inventor prevailed upon the owners to allow him a trial of his steam locomotive.

Stephenson himself was the driver on that occasion, and, before a tremendous crowd of curious and, for the most part, incredulous people, he drew a train of nearly thirty wagons, loaded with passengers and coal, at a speed of twelve or fifteen miles per hour. Thus the first train that ever carried passengers made its journey in safety, and the enthusiasm of the multitude was indescribable.

But, notwithstanding this demonstration, the locomotive was still unmercifully ridiculed by the majority. Nor was this ridicule confined to the ignorant classes; the ablest engineers contended that it was ridiculous to suppose that steam could ever be practically employed in competition with horse power for transportation. Almost incredible as it may now seem, it is a fact that political economists inveighed against the railway and the engine as constituting an imaginary reform, which, even if successful,—which was very doubtful,—would deprive stage-drivers, teamsters, and inn-keepers of their livelihood! It was in the face of an almost universal opposition, of the wild, unreason-

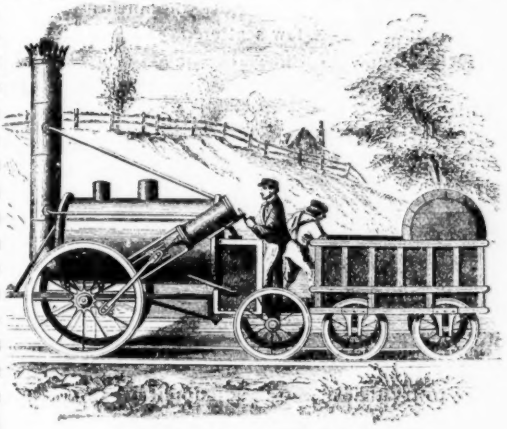


BLENKINSOP'S LOCOMOTIVE, "LORD WELLINGTON," 1811.

able kind, that a few men, led by the great Stephenson, labored steadily onward, and finally established the railroad and the locomotive as institutions of the land.

A great step in advance was made in 1829, when the Liverpool & Manchester Railway was finished. This was the most extensive and elaborate work of the kind that had ever been undertaken,—the first passenger railroad in the world,—and its opening on September 15 marked an era in civilization.

It was for this road that the famous "Rocket," already alluded to, was built by Stephenson. The directors had offered a reward of £500 for the best locomotive that should fulfil certain conditions, among them curiously enough, read in the light of the recent smoke-abatement agitation, being a provision that it should *consume its own smoke*. Besides this, it was to draw three times its weight at a rate of not less than ten miles an hour, the boiler pressure was not to exceed fifty pounds to the square inch, and the weight was not to exceed six tons. Of three engines which contested for supremacy the "Rocket" took the palm, attaining as its greatest velocity twenty-nine miles per hour and an average of fourteen miles, while drawing a tender and two loaded cars, the former weighing, with its water and coke, 3½ tons and the latter 9½ tons,—a total of nearly 12¾ tons. The consumption of coke was only 217 pounds per hour.



STEPHENSON'S "ROCKET," 1829.

The day was marred by one fatality, the locomotive claiming the first of the thousands of victims that were to lose life under its wheels. This was no less a personage than Mr. Huskisson, home secretary in the British cabinet, who, while talking with the duke of Wellington, in a throng of sight-seers, was run down by the now historic "Rocket." He was not killed outright, but died within a few hours, having in the meantime been conveyed to his house on another engine, the

"Northumbrian," by George Stephenson. On this ride the engineer pushed his machine to a speed of fifteen miles in twenty-five minutes, —a rate of thirty-six miles an hour, the highest that had then been attained.

The railroad and the locomotive were now unalterably fixed as a new force in the world's civilization. America closely followed Great Britain, and in its rapid adaptation and perfection of the machine outdid the older country. But it nevertheless was the case that the pioneer in America among practical locomotives placed on a track for traffic was an immigrant from England. It is one of the curiosities of railroad and locomotive history that it was not in, or near, any one of the great cities that this first locomotive was put upon the rails, but far away in the then raw region of northeastern Pennsylvania, in the woods and among a few scattered, newly-settled farmers.

The manner in which it came about that the pioneer locomotive in America was to be set at work in so remote a spot was this. Two Philadelphia Quakers, John and Maurice Wurts, about ten years prior to 1829, penetrated that wilderness, and heroically began and pushed forward the great work which later was assumed and carried to completion by the Delaware & Hudson Canal Company,—that of getting coal from the Lackawanna valley into New York. From the Lackawanna (at Carbondale) the company had built a railroad over the Moosic mountains to the forks of the Dyberry (the site of Honesdale), and from that point they had a canal to Rondout on the Hudson. It had been their original purpose to use horse power on the railroad, with stationary engines at the planes (as at present), but the successful experiments with the railroad locomotive in England led them to try that new form and application of power.

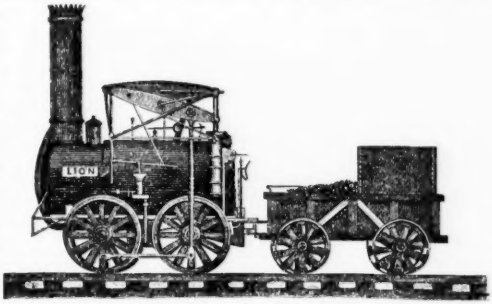
"The Stourbridge Lion," as the locomotive was called which "first turned a wheel upon a track in America," was one of three personally ordered by the company's civil engineer, Horatio Allen, in England. The "Lion" was built by Foster, Rastrick & Co. at Stourbridge, and the other two were built by Stephenson, who extended many courtesies to the American engineer. Thus it happened that early in 1828 the first order placed in England for locomotives, after the successful working of those on the Stockton & Darlington road, was from far-away America.

The "Stourbridge Lion" arrived on the ship John Jay, and was landed at the West Point Foundry Company's wharf at the foot of Beech street, New York, where it was set upon blocks and given a trial on June 11, 1829, as appears from the *Morning Courier and New York Enquirer* of June 12, which, after describing the test, says: "We were delighted with the performance of the engine, and have no

doubt but that the enterprising company to whom it belongs will reap a rich harvest for their enterprise and perseverance." It was noted as a matter of interest, because anthracite coal was then being introduced to the public, that the locomotive was fired with that substance from the Delaware & Hudson Company's Lackawanna mines. It was to put this coal in the market that the company's operations were inaugurated and carried on, and hence may be noted the significant fact that we are indebted to coal mining for the advent of the locomotive, in America as in England.

Great interest was manifested in New York in the marvelous mechanical importation, but it was not comparable with the curiosity and eager expectation into which the people of Honesdale and the surrounding country were thrown by the arrival of the "Lion."

The trial trip of the "Lion" was the talk of the country for a hundred miles around, so that when it came off, on August 9, 1829, a great crowd of people was present at the forks of the Dyberry, which locality, by reason of what occurred there then, is entitled to be considered one of the historic spots of America. A few of the people who witnessed that remarkable display of the first railroad locomotive in the world, outside of England, are still among the living.



THE "STOURBRIDGE LION." THE FIRST LOCOMOTIVE PLACED ON A TRACK IN AMERICA.

Its uniqueness and its significance render its recall from threatened oblivion worth while. The demonstration consisted of the running of the curious little machine a distance of about a mile and a half and then back, while the people shouted and hurrahed (after they had recovered from their first mute astonishment) and cannon boomed till the hills echoed.

Great as were the excitement and enthusiasm that day, it is probable that not a single soul in all the throng—even the most sanguinely imaginative one—had any adequate conception of the era that was there and thus inaugurated.

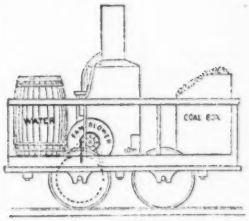
On that momentous occasion Horatio Allen, who had been intrusted with the purchase of the "Lion" and two other engines in

England, was the engineer and sole passenger. He had never run an engine before, and never did afterward, though he lived to be a very old man, had much to do with early railroad affairs, and died only a few years ago. He always took much satisfaction in being the driver of the first locomotive on an American track, but was sorry, in view of some developments, that it was not one of Stephenson's two locomotives, counterparts of the celebrated "Rocket," that made the first trial, instead of the "Stourbridge Lion," as in that case the exploit of the "Rocket" in England would have been anticipated in this country. He never knew until he saw it in a Chicago exhibition in 1883 that the boiler of the "Lion" had not been constructed in accordance with his orders.

The "Lion" was not wholly a success, but was sufficiently so to demonstrate entire practicability. This pioneer of locomotives was of nine horse power. It was a large and cumbrous affair, compared with engines of the same power in the present day. It was without a cab. The cylinders were upright, and a walking-beam on each side communicated the power to the wheels. The locomotive and tender were both four-wheeled, with spokes and felloes of wood, and iron tires and wheel centers. The boiler of this historically-important locomotive is all of it that is now in existence, so far as known, and is, or was until recently, in an iron shop in Carbondale.

Mr. Allen's exhibition of the "Stourbridge Lion" preceded by only a few weeks the Liverpool & Manchester Railway opening and locomotive contest made at Rainhill. America had in various ways anticipated the results of that demonstration of the engine's utility. Her inventive talent was already at work. Horatio Allen, who had come back from England the best informed man in America upon the locomotive, became its chief champion and promoter. He was positive that it was the railway motor of the future. In September, 1829, he went to Charleston to take the position of chief engineer of the South Carolina Railroad. He urged the adoption of steam instead of horse power upon that important road, on the broad ground that there was no reason to expect any material improvement in the breed of horses, while the man was not living who knew what "the breed of locomotives was to place at command."

Under his direction a locomotive called the "Best Friend of Charleston" was built at the West Point Foundry, New York city, and placed on the track November 2, 1830. This was the first locomotive built in America, and the second put upon a track. The South Carolina Railroad, one hundred and thirty-five miles in length, when formally opened in 1833, was the longest continuous railroad in the world.



PETER COOPER'S LOCOMOTIVE, 1829.

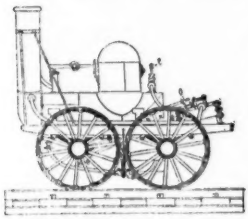
The Baltimore & Ohio Railroad had been commenced in 1828, and in May, 1830, the first section of fifteen miles, from Baltimore to Ellicott's Mills, was opened, but horse power only was employed. As early as 1829 no less a personage than Peter Cooper had experimented with a little locomotive of his own construction upon this line, and in 1875, at Cooper Institute in New York, he related with glee how, on the trial-trip, he had beaten a gray horse harnessed to another car.

Peter Cooper's locomotive was about as large as a hand-car of the present day, and the boiler, the size of a flour barrel, was of the "tubular" variety, the tubes being gun-barrels.

This engine was only a partial success, and in 1831 the Baltimore & Ohio Company, determined to push forward in the employment of steam power, offered the handsome sum of $4,000 for the most approved form of locomotive which should be delivered for trial by June 1, 1831, and $3,500 for the second best, the conditions being that the engine should not exceed three and one-half tons in weight and should be capable of drawing on a level a weight of fifteen tons, inclusive of wagons, at a speed of fifteen miles per hour.

In response to this call, there came the "York," built at Little York, Penn., by Davis & Gartner and designed by Phineas Davis. This product of American genius fulfilled the requirements, and subsequently the same firm built numerous other engines upon a modified plan, which resulted in what was known as the "Grasshopper" locomotives, which were used to some extent on the Baltimore & Ohio Railroad until recently. The "York" appears thus to have been the second practically successful locomotive of American construction.

In the same year a notable engine, the "DeWitt Clinton," was turned out for the Mohawk & Hudson Railroad by the West Point Foundry, and made its first successful trip with passengers from Albany to Schenectady on August 9, 1831, drawing what has been very widely and erroneously called the "first railroad train in America,"—for both the South Carolina and the Baltimore & Ohio roads were in operation, with steam power, earlier.



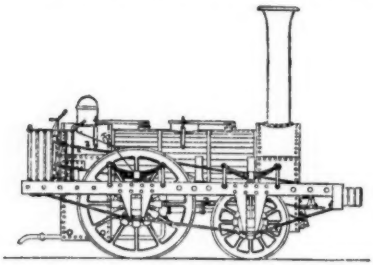
THE DE WITT CLINTON, 1831.

John Stevens and Matthias W. Baldwin were two remarkable men who figured

conspicuously and influentially in the early history of the railroad and the locomotive. To the former, who was a locomotive inventor of Hoboken, New Jersey, and had experimented successfully as early as 1826, and to his sons, Robert, Edwin, and John, the projection and building of the Camden & Amboy Railroad were largely due. This accomplishment was fruitful of results, and set in operation a sequence of events very important in the evolution of the locomotive.

It was for this road that the engine "John Bull," built by George and Robert Stephenson & Co., was imported, and it was this little machine that afforded the first object-lesson to Matthias Baldwin, a Philadelphia bookbinder, who was destined to be one of the greatest locomotive-builders in the world.

Stevens, who had witnessed the successful trial of Stephenson's "Planet," had given its builders an order, in 1830, for a locomotive of similar construction, and it was the "John Bull" thus built which duly arrived in Philadelphia and was given its initial trip on the Camden & Amboy road at Bordentown, New Jersey, on November 12, 1831. While the "John Bull" (which was honored with a place in the Columbian Exposition at Chicago) was housed in Philadelphia, and closely guarded from public view, awaiting the trial-trip at Bordentown, Baldwin obtained a view of it, and carefully studied its mechanism. The bookbinder, who was noted as a skilful mechanic and general genius, did this at the solicitation of his friend Franklin Peale, proprietor of the famous Peale's museum in Philadelphia, who, to gratify the intense curiosity of the public on all points concerning the locomotive, wished to place one on exhibition, and desired Baldwin to build it for the purpose. Baldwin, who had already built for his own use a stationary engine, looked the "John Bull" over carefully, and finally announced in a determined way: "I can make it."



THE "PLANET;" AN EARLY ENGLISH TYPE, 1831–35.

Matthias Baldwin's first locomotive, it thus happened, was built as a museum attraction. He produced it after four months of most assiduous labor with his own hands, and with no other aid than his inspection of the English locomotive and a few drawings afforded him. This pioneer Baldwin locomotive, when completed, was put upon a little

track making the circuit of the Museum in the old Arcade, and worked smoothly and well, drawing two miniature cars which contained seats for half-a-dozen passengers. Crowds came to see the wonder, and were delighted. It was a pronounced success as a museum attraction, and an educator of the public, and it did much to "boom" the railway idea by making its practicability patent to the popular mind.

Mere toy as it was,—it weighed only two hundred and twenty-four pounds, including its two-gallon boiler and iron wheels,—it was the start in Baldwin's great career. The success of the museum attraction led to the ordering of a locomotive of Baldwin manufacture by the Philadelphia & Germantown Railroad Company, and the "Old Ironsides" which resulted and was placed on the track November 23, 1832, was one of the most efficient and famous locomotives of the day. The price that Baldwin received for the "Old Ironsides" (the first railroad locomotive built in Philadelphia) was $3,500, which was $500 less than the contract specified. The company came near rejecting it because its weight was nearer seven than five tons; it was thought (though groundlessly) to be too heavy for the track. Had it been rejected, Baldwin would probably never have built another. As it was, he remarked, in accepting the reduced sum, that it was his last locomotive; but he lived long enough to build 1499 more, for at the time of his death the one building at the great works he established bore the number 1500.

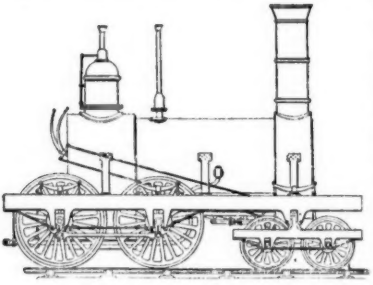
After the successful trial of the "John Bull" on the Camden & Amboy Railroad in 1831, a number of locomotives built by the Stephensons were imported from England, most of which were of the class typified by the "Planet," and these furnished in a general way the pattern for those constructed here for a time. But gradually, as new ideas arose, and as the locomotive was adapted, by various changes and improvements, to existing conditions, the American types and patterns became very different from the foreign.

Among the first of these improvements was one in which Horatio Allen, of "Stourbridge Lion" fame, again came to the front, in May, 1831. The axles of the two pairs of wheels, instead of being held inflexibly parallel with each other, were made to turn upon kingbolts, thus greatly facilitating the passage of curves. This principle was afterwards worked upon by John B. Jervis and Ross Winans; was made the subject of extensive litigation by the latter; and was eventually, in an improved form, applied to cars and nearly all of the rolling-stock in the country. From this time onward the history of the locomotive moves fast and is crowded with events. We have already noted the inception of the Baldwin Locomotive Works. It remains to be said that that other great concern, the Norris Locomotive Works,

had its origin in March, 1831, in the American Steam Carriage Company, formed in Philadelphia by Col. Stephen H. Long, U. S. A., William Norris, and others; and in 1835 the Rodgers Locomotive Works were started in New York, in a small way, by Thomas Rodgers.

The years 1836 and 1837 are notable in locomotive history as being the dates of two inventions which, more than any others, gave the engine an approach to the appearance it bears to-day. In the former year Henry R. Campbell of Philadelphia patented the use of two pairs of driving-wheels and a truck; and in the latter John Scotti of Baltimore (who died in 1891) invented the locomotive cab, without which any locomotive would appear very strangely to-day.

How rapidly locomotive-building grew in this country is illustrated by the fact that the Baldwin Works finished fourteen in 1835, and forty the succeeding year, and how greatly the mechanical excellence of the machine was enhanced by American genius is indicated by the production in 1836, from the Norris Works, of the "George Washington," so powerful and so scientifically made a locomotive that it performed a feat which American and English engineers had pronounced an impossibility, and took the whole engineering world by storm. It ran up an inclined plane, on the Columbia & Philadelphia railroad, two thousand eight hundred feet in length, with a rise of one foot in fourteen, drawing a load of over nineteen thousand pounds, besides the weight of the engine, at a speed of fifteen miles an hour.



CAMPBELL'S LOCOMOTIVE, 1836.

Significant enough, and forming a typical illustration of American push, is the fact that in the year 1837, only eight years after America had imported her first locomotive, a very satisfactory engine was built for the Austrian government by the Norris Works of Philadelphia. And it was more emphatically demonstrated that America, originally an importer, had become an exporter of locomotives, when in 1839 the Baldwin Works received orders for a large number from railroad companies in England.

It was something of the same spirit and condition of things, manifested in that early day, that has made this country the producer of nearly 2,500 locomotives per annum, and the employer of more than 35,000.

THE ADVANTAGES OF MECHANICAL STOKING.

By A. E. Outerbridge, Jr.

THE brilliant scientific investigations of Tyndall which revealed an intimate and hitherto unsuspected relation between the presence of smoke in the air and the frequent formation of dense fogs in London, supplemented by observations of eminent physicians, and official publications of the board of health of London, showing that pulmonary and other complaints were caused and aggravated by breathing fog and soot intermingled,—in fact, that every dense, sooty fog was responsible for an appreciable increase in the death-rate of the city,—served to arouse public interest in the subject of smoke prevention in England long before it attracted serious attention in this country.

As long ago as 1843 the house of commons appointed a royal commission of fifteen members, including the lord mayor of London, to investigate the subject of smoke prevention.

This commission summoned and examined more than a score of chemists, metallurgists, physicians, and manufacturers, among whom appear the familiar names of Faraday, Ure, Brande, and other distinguished specialists of the time. The metropolitan police were provided with inspection cards, upon which they recorded the character, density, etc., of smoke discharged from hundreds of factory chimneys. The results of the observations made were elaborately tabulated, and illustrations were drawn by an artist showing groups of factory chimneys all pouring forth clouds of smoke. These exhaustive investigations were printed by order of the house of commons, and form a large official volume, a copy of which (perhaps the only one in this country) may be found in the library of the Franklin Institute.*

* The witnesses were examined upon the following questions, and the conclusions of the committee are given herewith:

I. Whether it is practicable to prevent, or diminish, the nuisance now so severely felt in large towns and populous districts from the smoke of furnaces or of steam engines?

II. Whether, if this were practicable, it would be advisable to take any steps to prevent the nuisance, as so doing might interfere with the property or interests of manufacturers, or of the proprietors of furnaces?

III. In the event of the two former questions being answered in the affirmative, would you recommend some legislative enactment to be framed to prevent the nuisance of smoke?

The consensus of opinion of the scientific and practical men, including master manufacturers, was that smoke, which is the result of imperfect combustion, may in all cases be diminished, if not entirely prevented. The report says: "The evidence before your committee further shows that the admission of atmospheric air, under proper regulations, into the furnace is productive of saving in fuel, by causing the particles of carbon, which would otherwise rise in smoke and be wasted, to ignite, and thereby to increase the heat in the boiler."

In conclusion, the committee recommended that a bill should be brought into parliament at an early period of the next session, to prohibit the production of smoke from furnaces and steam engines.

In the early days in America, when factories were situated in sparsely-settled districts and fuel was cheap, the importance of smoke consumption was not as apparent as it is to-day. The subject has now attained prominence largely by reason of municipal regulations which have been passed in many cities (and are about to be enforced) restricting the pollution of the atmosphere by smoke from soft coal and instituting fines and penalties therefor.

The citizens of Pittsburg were afforded a grand object-lesson, during the reign of natural gas, by the increased comfort, cleanliness, and healthfulness of the city resulting from the substitution of clear atmosphere for the smoky pall in which they were formerly, and are now again, to some extent, enveloped.

Very recently Mr. F. W. Duenckel, the observer in charge of the Forest Park meteorological observatory near St. Louis, contributed some interesting information to the discussion of the smoke nuisance in that city. Noticing that there were, at times, greater differences between temperature readings at his station and those at the United States weather bureau in St. Louis than were warranted by the intervening distance of $4\frac{1}{3}$ miles, Mr. Duenckel plotted the readings for some years. In calm weather the smoke from factories hangs over the city, preventing radiation and consequent cooling at night, and refracting the sun's rays during the day. This interference with radiation Mr. Duenckel considers detrimental to health, to say nothing of the injurious effect of the carbon in the atmosphere.

The city of St. Louis passed an ordinance [17,049] in 1893 declaring the emission of dense black or thick grey smoke to be a nuisance, and providing for the suppression thereof. It was further ordained by the municipal assembly as follows:

Section I. "The president of the board of public improvements is hereby authorized and directed to appoint, with the approval of the mayor, a commission composed of three competent persons, who shall not be directly or indirectly interested in the manufacture, sale, or construction of any furnace or other article having practical relation to the production or prevention of smoke. Said commission shall ascertain by a thorough canvas of the city, and report to the board of public improvements, within four months after their appointment, the conditions and liabilities under which manufacturing, and other parties, cannot wholly or reasonably prevent the occasional production of dense visible smoke. Such ascertained conditions and liabilities, when approved by the board of public improvements and mayor, shall be published, and thereafter shall constitute instructions to guide and limit the officials charged with the enforcement of smoke-suppression ordinances. And it shall be a valid and sufficient defence against any complaint that the offence charged comes within such recognized conditions and liabilities.

In accordance with this provision a smoke commission was appointed; the members were Messrs. Wm. B. Potter, Wm. H. Bryan, and Wm. McClellan. The report of this commission, approved by

the mayor of St. Louis, was published in pamphlet form, and is before the writer. It appears that the various boiler plants and all other kinds of furnaces and smoke-producing fires were classified, and a sufficient number of types in each studied in detail to secure the data necessary to the formation of a proper judgment in any individual case. It was found that, "notwithstanding the many variations in type of boilers and of setting, and of kind and conditions of service, occurring in the city, and in spite of numerous instances of defects in construction, arrangement of accessory parts, or in location, there are very few cases where the conditions and liabilities are such that some means cannot be employed successfully to wholly or reasonably prevent the production and emission of dense visible smoke."

Exceptions are noted, as in the case of certain metallurgical operations where reverberatory furnaces are used, requiring a neutral smoky flame in the hearths for a successful product; also in kilns for burning brick, tile, sewer-pipe, pottery, muffle and tinning furnaces, etc. In these cases certain suggestions for improvements are made, and it is stated that, in puddling, re-heating, annealing, steel-melting, and ore-roasting furnaces, the character of the heat applied is such that any change with a view to abating the smoke produced would seriously interfere with the working of the furnaces, "constituting for the present a valid and sufficient defence against any complaint of violation of ordinance No. 17,049 on the part of any company through the operation of the above-named furnaces."

An appendix contains a description of the methods of testing smoke-abatement devices, giving "general plan," "weighing and measuring coal, ash, and clinker," "water," "heating surface," "horse power," "gas analyses," etc.*

The meteorological records of the superintendent of the Forest Park observatory, near St. Louis, indicate that the smoke-abatement ordinance has not as yet been generally observed, but it is doubtless wise forbearance on the part of the authorities to allow sufficient time to elapse to thoroughly test the efficiency and durability of various smoke-consuming appliances which have been installed since the passage of the ordinance.

New Orleans, Cincinnati, and other cities passed laws relating to

* The ordinance [17,049] referred to reads:

"Be it ordained by the municipal assembly of the city of St. Louis as follows. The emission into the open air of dense black or thick grey smoke within the corporate limits of the city of St. Louis is hereby declared to be a nuisance. The owners, occupants, or agents of any establishment, locomotives, or premises from which dense black or thick grey smoke is emitted or discharged shall be deemed guilty of a misdemeanor, and, upon conviction thereof, shall pay a fine of not less than ten nor more than fifty dollars, and each and every day wherein such smoke shall be emitted shall constitute a separate offence. This ordinance shall take effect at the expiration of six months after approval by the mayor." Approved February 17, 1893.

smoke discharge many years ago, but they have been ignored. The St. Louis ordinance, which was carefully prepared, and is about to be enforced, is, therefore, chosen as a representative of restrictive legislation. Within the past year Pittsburg has passed a similar ordinance "to regulate and suppress the production and emission of smoke from bituminous coal, and to provide penalties for the violation thereof."

Inspectors have been appointed, provided with rules and appliances for approximately determining the amount of smoke discharged daily from factory chimneys. Other cities are adopting the same restrictions, and it is evident that the time is now approaching when this problem must be solved, either by the voluntary action of the manufacturers, or by law. The attention which is being devoted to discussions of the smoke nuisance in the engineering magazines and other technical papers further proves that this is a live issue to-day.

It may be accepted as a fact that the discharge of soot, or unconsumed fuel, from a chimney is a nuisance, destructive to the neighboring property and detrimental to health. The question then logically follows: "Is it possible and practicable to economically consume smoke under boilers?" *

Granting such possibility, are the appliances durable, and are they equally adaptable to externally- and internally-fired boilers?

The fact that several thousand boilers of different types are daily fed by mechanical stoking appliances, and that the number is increas ing rapidly, points to an affirmative answer, and it does not seem hazardous to predict that the majority of large boiler plants using bituminous coal will be equipped with automatic stokers within a few years.

An article in the *Iron Age* (March 5, 1896), entitled "Smoke-Consuming Appliances and Smokeless Powders," revealed an unexpectedly close relationship between these two lines of investigation, and it is interesting to note that smokelessness of powder for modern guns "came as an unsought factor, but an inseparable one. Higher power means complete combustion, and complete combustion means smokelessness." It is shown by Colonel Farley that a flatter trajec-

* "Within the corporate limits of the city of Chicago there are located fifteen thousand steam boilers, of which not less than twelve thousand are consumers of soft coal. These are scattered over one hundred and eighty-six square miles of territory. No two plants are alike, and in almost every case which comes under the inspection of the smoke bureau there are special defects to be overcome. . . . . The maintaining of the smoke nuisance in the down-town district is an inexcusable outrage. . . . . I know of an instance in which a restaurant firm so consumed $600 worth of coal as to cause an actual damage to adjacent property exceeding $25,000. In another instance an apartment building under the management of a receiver, protected by the court against the enforcement of the smoke ordinance, ruined the furniture and furnishings of every residence for two blocks in its neighborhood, and depreciated the value of adjacent real estate more than one-third of the former value." *Report of Chief Smoke Inspector F. W. Adams. Published in the annual report of the department of health of the city of Chicago, 1894.*

tory, increased range, greater velocity, greater penetration, and decreased weight of powder in cartridges have resulted from the perfect combustion of smokeless powder. The paper states that "no more convincing argument as to the increased efficiency resulting from perfect combustion could possibly be offered than the experiments with smokeless powders. They are accurate quantitative analyses of combustion of fuel."

No one realizes more fully than the analytical chemist the difficulty of obtaining complete combustion of carbon. It seems an easy matter to thoroughly burn a few grams or grains of powdered carbon in an open platinum vessel when subjected to a white heat; yet such an operation is a tedious one, often consuming hours, and sometimes requiring the use of powerful oxidizing agents. It is not surprising, therefore, that a large percentage of unconsumed carbon passes off from an ordinary furnace, and the fact that bituminous "slack" can now be continuously fed into a fire-box without visible smoke appearing from the chimney-top is a fine testimonial to the mechanical excellence of appliances which so closely approximate the perfection of laboratory apparatus and methods. There are several forms of mechanical stokers designed to practically accomplish this result; but complete combustion does not necessarily mean economical practice. An excess of air over the exact amount required facilitates combustion, but also causes loss of heat energy. The atmosphere, being a mixture of 23 parts of oxygen with 77 parts of nitrogen, will quickly rob the furnace of its heat, if too freely admitted to the burning fuel.*

The well-established rules governing the amount of grate surface, proportion of fuel per square-foot of grate surface, etc., require to be carefully observed in designing mechanical-stoking appliances. Economy of fuel is not the most important consideration in mechanical stoking; in large plants the saving of labor is a much larger item, amounting (according to the calculations of experts who have studied the subject) to fifty per cent., or more, in some cases.

Economy of fuel in successful mechanical stoking results not solely or chiefly from combustion of smoke, but from the more uniform feeding of "green" coal to the furnace, entirely avoiding the opening of fire doors, with consequent drop of steam pressure, etc. Incidental advantages and economies, such as prolonged life of boilers due to regular firing, etc., are claimed by makers of mechanical stokers, and, if there were no offsetting disadvantages, the use of such appliances

* To find the quantity of air at 62° F. under one atmosphere chemically consumed in the complete combustion of one pound of a given fuel, and to ascertain the quantity of surplus air that enters a furnace, see "Manual of Rules, Tables, and Data for Engineers; by Daniel Kinnear Clark," p. 400 *et seq.*

would, presumably, be universal instead of exceptional. The cost of an effective and durable mechanical-stoking plant limits its application, and the uncertainty as to the actual economy has hitherto further retarded the general introduction.

Economy of operation depends upon many details of construction: (1) every part of the machine must be readily accessible for repair; (2) the mechanism must be sufficiently simple to be operated by a man of ordinary intelligence, without frequent supervision; (3) the feeding of fuel must be at all times under perfect control of the attendant, so that the fires may be checked or augmented as desired; (4) automatic arrangement for continuously feeding the coal in a thin, even layer, over the entire grate-bar surface, and for constant progressive movement of the body of fuel to prevent formation of clinker, must be provided; (5) the grate bars and other parts of the mechanism which are subjected to heat must be designed to resist distortion, burning out, and other causes of rapid deterioration; (6) the stoker must be adapted to the use of cheap fuel.

These are the essential qualifications of all successful stokers; there are other features which, though less necessary, add to the utility and convenience, and thus distinguish one form of stoker from another. The possibility of smokeless combustion is clearly shown to be only one factor in the determination of the relative merits of different forms of mechanical stokers. It is, indeed, possible by careful hand-firing, in well-designed furnaces, provided with combustion chambers, dampers, or other appliances for regulating the supply of air, and by constant intelligent supervision, to burn soft coal with comparatively little discharge of black smoke from the chimney; and one of the indirect beneficial results of the introduction of successful mechanical stokers in large boiler plants will, doubtless, be an improvement in methods of hand-firing in small establishments which cannot afford the expense of a mechanical-stoking outfit. Thus one installation of a practically successful mechanical stoker in any manufacturing locality serves a double purpose, and the several cities which have passed ordinances regulating smoke discharge are wisely taking the initiative by introducing complete mechanical-stoking appliances at the public boiler plants. It is apparent from the foregoing broad statement of principles of mechanical stoking that durability of machinery and economy of operation are far more important considerations in any appliance of this character than the mere question of first cost.

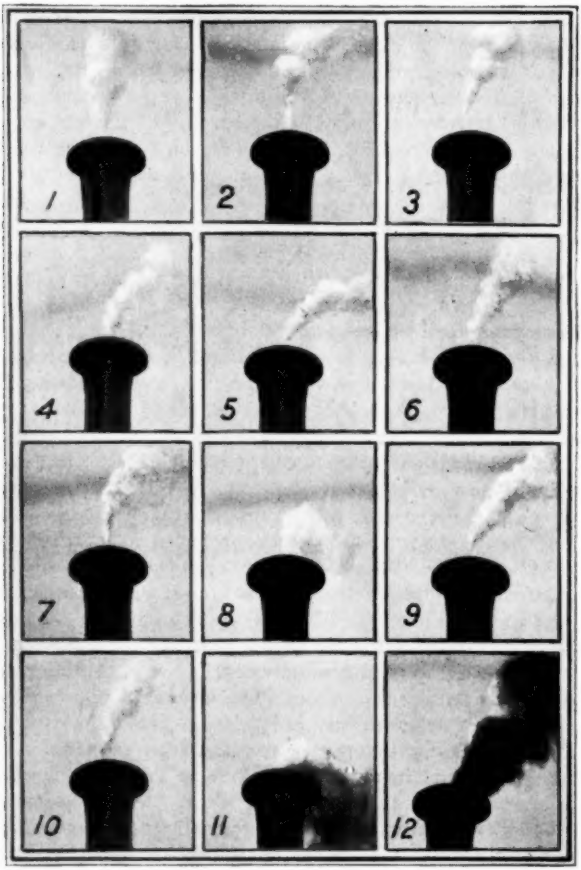
The principle upon which the mechanical stokers operate is extremely simple. There is usually a hopper or receptacle into which the coal is thrown, either by shovelling or by conveyors; the coal is pushed forward by a continuous or an intermittent movement, into the

furnace upon the grate-bars ; these are sometimes provided with reciprocating motion, and sometimes made in the form of an endless chain. The coal is spread by various devices more or less evenly, and gradually travels toward the back of the furnace, where a combustion chamber is often provided to complete the burning of the fuel and gases. In some forms the coal is fed underneath the bed by a "worm" or other conveyor, and pushed up through the burning mass at proper places.

Some forms of stokers are adapted to bituminous or coking coal, and others to anthracite fuel. Some are adapted for externally-fired boilers only, others for internally-fired boilers, while still others may be modified to suit varying conditions.

A striking proof of the practicability of complete combustion of smoke, even when feeding bituminous slack, by means of an automatic mechanical stoker, is afforded in the illustration on the next page, showing twelve photographs of the top of a foundry stack, taken at intervals of two minutes apart, at a time when the stoker was feeding 35 pounds of bituminous slack per square foot of grate-bar per hour, to the furnace of a boiler and developing over 200 h. p. Nos. 1 to 10 inclusive show the results with the mechanical stoker working under usual conditions, the only visible escape from the chimney being that of steam from an engine exhaust-pipe which had no connection with the stoker. At a given signal the automatic stoking appliance was cut out, the fuel added, and the fire raked by hand. The smoking capabilities of the fuel were immediately exhibited by the emission of dense black smoke from the chimney top (as shown in Nos. 11 and 12), which continued to pour forth until the mechanical-stoking apparatus was again put into operation, when the smoke was immediately and entirely consumed.

It would seem unwise, or inappropriate, in a paper which aims to give a general and impartial view of the advantages of mechanical stoking over hand firing, and to present briefly the fundamental principles underlying the construction and operation of all successful appliances of this character, to discuss the relative merits of different forms of stokers. It would be difficult, if not impracticable, to cover the whole field, and there would be danger of doing some one unintentional injustice by an oversight or omission. For the foregoing reasons it is deemed preferable to confine this paper to the historical and general treatment of the subject. All of the statements here made tend to prove that the time is approaching, if indeed it has not already arrived, which was clearly anticipated by a former generation,—a time when the intolerable smoke nuisance in cities where soft coal is used must be abated, if not entirely suppressed. It appears, moreover, that mechanical appliances for accomplishing this object have now been so far



perfected that the one-time fear that smoke ordinances would prove impracticable, or, would, at all events, impose hardship upon manufacturers, no longer obtains; on the contrary, it is more than probable that self-interest will lead large industrial establishments to adopt, voluntarily, smoke-consuming appliances as soon as the many advantages of mechanical stoking are made manifest. The object of this paper is to further that end.

THE ARCHITECTURE OF OUR GOVERNMENT BUILDINGS

By Wm. Martin Aiken.

THERE has been no period in the development of this country (certainly not since the agitation of the slavery question) when the people at large have taken so deep an interest in national affairs as now. And this interest is not exhausted in questions which are decided by the ballot, or by the executive, judicial, or legislative branches of our government, but extends to every department which in any manner contributes to the material welfare, importance, or dignity of the country. This general and sincere appreciation of public affairs is certainly one of the strongest proofs of the stability and permanency of our institutions.

There is, under the control and direction of the secretary of the treasury in Washington, an office which supplies a certain stimulant to this interest, since with it originates, and through it is materialized, the "local habitation" for many government officials in every one of these United States,—namely, the office of the supervising architect.

It has been constantly asked why this bureau of construction should be a branch of the treasury department. It should be remembered that our country has not always been so large, so densely populated, or so well acquainted with its own resources, as it now is. When, in 1853, Secretary Guthrie undertook to organize such a bureau and made application to the secretary of war "for a scientific and practical engineer," to Capt. Alexander H. Bowman, of the engineer corps of the army, was entrusted the duty of providing for the repair and preservation of 23 buildings belonging to the government and of supervising the designing and construction of 15 more for which congress had made appropriations, whereas at present 316 buildings, completed and occupied, are in charge of the supervising architect, to say nothing of 66 more, the construction of which has been ordered by congress. In those days the duties were confined mainly to the making of plans and estimates for custom-houses, mints, and marine hospitals, and the general superintendence of their construction. Since custom-houses were intended for the use of collectors of the government income, and mints for the coinage of currency, it was but natural that the secretary of the treasury should control their erection. By degrees the construction of appraisers'

stores, post-offices, court-houses, and quarantine stations have been added to the duties of this office. In 1863 the annual report was made by Mr. Isaiah Rogers, who seems to have been the first officer to subscribe himself as "Supervising Architect," and who previously had been employed to design the custom-house at Boston and certain other government buildings.

The incumbents of the office up to the present time have been the following:

Isaiah Rogers,	appointed	June 10, 1863.
A. B. Young,	"	1865.
A. B. Mullett,	"	May 29, 1866.
Wm. A. Potter,	"	January 20, 1875.
James G. Hill,	"	August 11, 1876.
M. E. Bell,	"	November 10, 1883.
Will. A. Freret,	"	July 21, 1887.
James H. Windrim,	"	March 28, 1889.
W. J. Edbrooke,	"	April 20, 1891.
Jeremiah O'Rourke,	"	April 20, 1893.

As the duties of the office have increased, so also has its organization been extended, subdivided, and combined, until now there are eight divisions. Two of these (the law and records division and the accounts division) are under the special charge of the chief executive officer, Mr. Charles E. Kemper, who, from September, 1894, to April, 1895 (the interim between the resignation of the last and the appointment of the present supervising architect), administered the affairs of the office, and, under the guidance of the secretary and assistant secretary of the treasury, was able to effect certain changes and modifications which had long been desired by every previous holder of the office. The result of this reorganization relieves the architect of the actual supervision of clerical work, and permits him to devote his time and attention to the other six divisions. These are known as: (1) the engineering and drafting division (where the designs are made and the construction laid out); (2) the computing division (where estimates of cost and specifications governing construction are made); (3) inspection and materials division (which issues instructions to, and receives reports from, superintendents, and directs the movements of special inspectors who visit buildings in progress of construction or repair); (4) repairs division; (5) photographing division (which reproduces by photographic process the drawings required for works of construction or repair); (6) the tracing division.

Thus it may be seen at a glance that, although the general public is under the impression that the majority of the employees of this

POST-OFFICE AT BUFFALO, N. Y. GOTHIC TYPE, MASSES SIMPLE AND FORMAL; ORNAMENT CONCENTRATED.

office are draftsmen, as a matter of fact these constitute less than one-third of the total number employed, the execution of the work requiring the services of many stenographers, typewriters, and other assistants. In addition to the files of correspondence, reports, specifications, contracts, deeds (of property purchased), etc., there are also files of all kinds and descriptions of materials submitted by contractors for use in the construction of the buildings, such as stone, marble, brick, terra-cotta, tiles, wood, hardware, plumbing-fixtures, etc. The initial movement towards the erection of a government building is the framing of a bill by one or more members of congress from that section of the country in which the proposed building is to be located, which bill is formulated upon information received from officials of the various departments contemplating the occupation of such building, together with the approximate estimate of cost furnished by the supervising architect. This bill then undergoes the scrutiny of the committee of public buildings and grounds, as well as that of the appropriation committee of both houses, after which, to become a law, it must receive the approval of the president.

A portion of the appropriation is set aside for the purchase of the site, and, after it has been purchased, and the title has been approved by the department of justice, and the property rights have been vested in the government, the preliminary drawings and estimate are prepared for the signature of the secretary of the treasury, postmaster-general, and secretary of the interior, whose approval is required by law before any working drawings can be made. The supervising

POST-OFFICE, BEAVER FALLS, PA. STYLE SUGGESTIVE OF NORTHERN CENTRAL EUROPE, ADAPTED TO AMERICAN CONDITIONS.

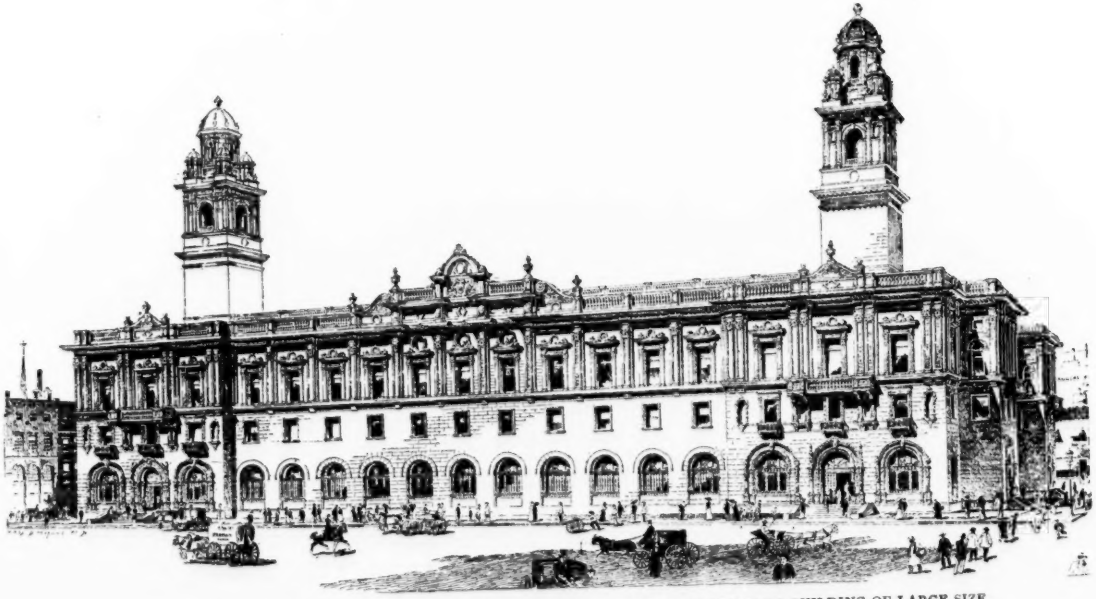
POST-OFFICE AND CUSTOM-HOUSE, NEW LONDON, CONN. OLD COLONIAL TYPE OF NEW ENGLAND.

architect has, in the mean-time, visited the site, in order that the design may conform as accurately as possible to the requirements of the purposes for which the building is intended, and that the environment may be given proper consideration. The influences which now chiefly affect the character of the design proceed from causes climatic, geological, and historical,—relations which have always existed between local conditions and logical design, even from prehistoric ages and in every part of the world. Thus, within that portion of our country to the north of the isothermal line extending from Cape Hatteras, and to the east of the Missouri river, the roof is generally given a steeper pitch, to shed more quickly the heavy rains or snows, as shown in the designs for government buildings at Buffalo, N. Y., New London, Conn., Paterson, N. J., Beaver Falls, Pa., Madison, Ind., Richmond, Ky., Clarksville, Tenn., and Saginaw, Mich. For buildings situated to the south of that mysterious North Carolina line, and to the west of the Missouri river, roofs of gentler slope are indicated, the rainfall requiring less consideration and the radiation of the sun's rays more, as in the designs for buildings at Meridian, Miss., Pueblo, Col., Denver, Col., San Francisco, Cal., and Portland, Ore. Those who have visited Italy can appreciate the importance—yes, the absolute neces-

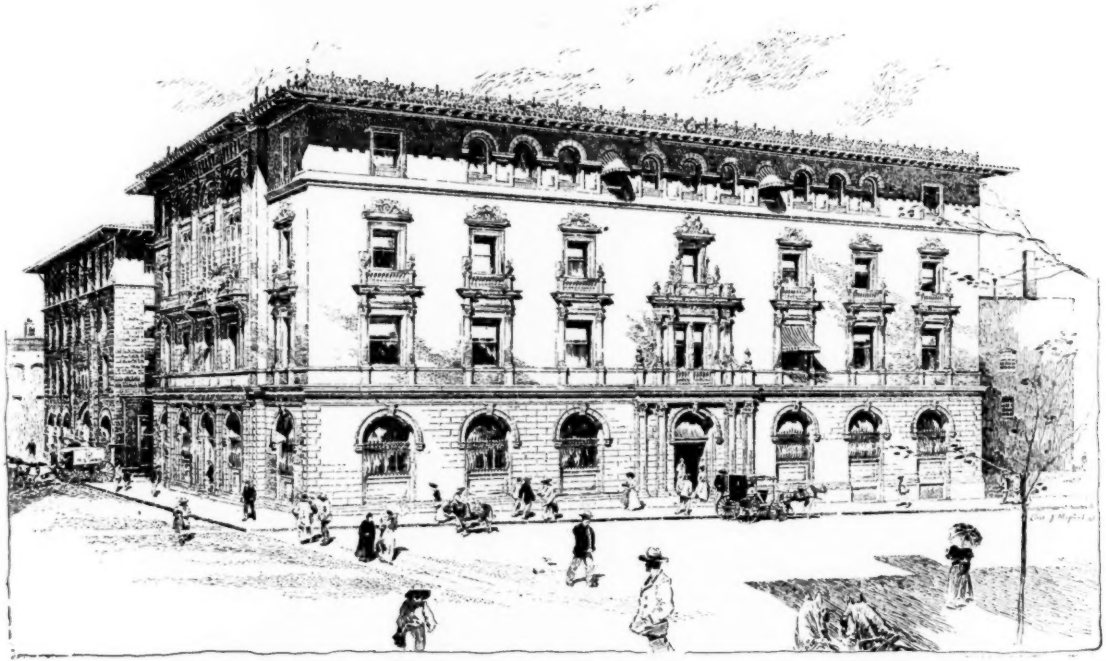
POST-OFFICE, RICHMOND, KY.

sity—of sunshine for the enjoyment of life in that land, and in "Our Own Riviera" Mr. Howells has indicated with his inimitable touch many subtle distinctions produced by differences between the climatic conditions of the Atlantic and Pacific slopes. In the government buildings about to be erected at San Francisco, and at Portland, Ore., this has been recognized in plan as well as in elevation, the former having a U-shaped and the latter an H-shaped plan, with no interior light-shafts, all rooms receiving light and air directly from without.

The legend "*E Pluribus Unum*" indicates that we are a nation of many peoples, and this sentiment is given proper weight in the historical influences affecting the design of our national edifices. The



POST-OFFICE AND COURT-HOUSE, SAN FRANCISCO, CAL. SPANISH STYLE ADAPTED TO BUILDING OF LARGE SIZE.



POST-OFFICE, PUEBLO, COL. ADAPTATION OF SPANISH STYLE TO A BUILDING OF MODERATE SIZE.

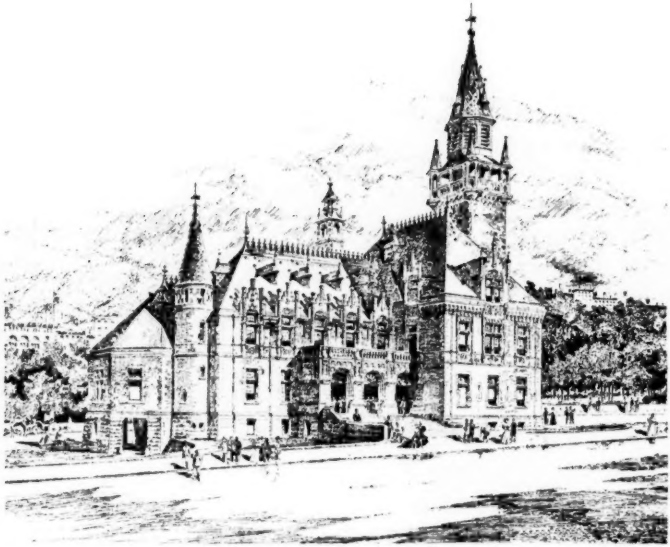
post-office and court-house in San Francisco is to be built on Seventh and Mission streets, and will contain the old Spanish records of a State or city whose early history has a decidedly Spanish flavor. Not only the primitive adobe buildings still seen and used, but the very name of the city, proclaim the origin of Pueblo, Colo.; what, then, more logical than the adaptation of the Spanish style of architecture to the buildings in these cities?

In a publication entitled "The County of Saginaw," by Wm. H. Sweet (May 26, 1896), is the following statement: "The first settlers in the valley located therein in 1815; they were mostly of French origin or half-breeds; their avocations chiefly trading with the Indians,

POST-OFFICE, SAGINAW, MICH. SUGGESTING FRENCH TRADITIONS. STYLE OF A CHATEAU OF THE VALLEY OF THE LOIRE.

hunting, and fishing." The post-office in Saginaw is accordingly French in style, the corner towers being suggestive of the defensive feature of frontier life, while the carving of the pinnacles and finials was suggested by the fauna and flora of the neighborhood.

Among the earliest settlers of Paterson, N. J., were a number of Flemish silk-spinners and weavers, so that, in the course of time, the silk industry grew to be a very important one; the post-office in that city, therefore, suggests, in the style of its architecture, the nativity of its first substantial citizens. In the buildings at Pawtucket, R. I.,



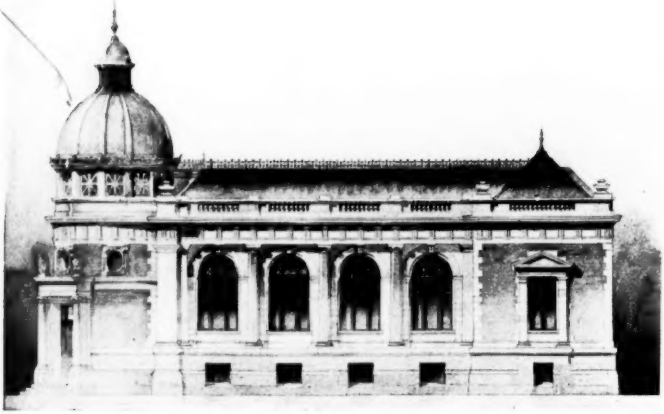
POST-OFFICE, PATERSON, N. J. FLEMISH TYPE OF PICTURESQUE URBAN ARCHITECTURE.

POST-OFFICE, LYNN, MASS. MODERN TYPE OF CENTRAL AND WESTERN EUROPEAN CIVIC ARCHITECTURE FOR BUILDINGS OF MODERATE SIZE.

CUSTOM-HOUSE, PORTLAND, OREGON. TYPICAL OF MODERN CIVIC ARCHITECTURE OF CENTRAL EUROPE FOR LARGE BUILDINGS.

and Lynn, Mass., the direct business methods of the citizens, with the academic training of so many communities of that section, have been recognized in designs suggestive of the training which architects receive from the "Ecole des Beaux Arts" in Paris, the most notable school of architecture of the present day, where many of our foremost architects have studied. The mint buildings at Denver and Philadelphia have called for special treatment, the conditions governing each being entirely different, not only from those of other government buildings to be designed and erected at this time, but from those governing the other. These two (and the Portland building) are fortunate in fronting upon wide streets, thus permitting the use of broad and simple motives. A mint, being a money-making building, can

THE MINT, DENVER, COLORADO. STYLE OF THE MEDIEVAL PALACES OF FLORENTINE BANKERS.



POST-OFFICE, PAWTUCKET, R. I. TYPICAL OF WESTERN AND CENTRAL EUROPEAN CIVIC ARCHITECTURE FOR MODERATE SIZED BUILDINGS.

POST-OFFICE AT MERIDIAN, MISS. TYPE OF BUILDING IN ITALIAN STYLE, ADAPTED TO SOUTHERN CLIMATE.

well afford to assume somewhat of an industrial air; yet in these two instances (being situated on the border line between the residential and commercial sections of their respective cities) the surroundings have received special consideration, with a result which may be discernible. Since it is always the desire of the supervising architect to specify such materials as are generally acknowledged by a community to be suitable for building in that locality, the design for the Denver mint recognizes in its motive the sturdy, robust Florentine palace with the possible use of the local red (or gray) granite or the red sandstone, which would show to advantage in the clear atmosphere of Colorado.

THE POST-OFFICE AT MADISON, INDIANA. ROMANESQUE TYPE, ROBUST AND SIMPLE.

The traditions of the Old Mint and of certain other buildings in Philadelphia have called for the manifestation of a more classical feeling in its successor, leading to the consideration of a white marble exterior. In the Buffalo post-office, court-house, and custom-house,—the largest and one of the most important buildings designed in this office within the past two years,—a mottled pink granite is being used, as the best material obtainable within a reasonable distance; and a rather free treatment of early Gothic has been chosen as the style, being capable of greater refinement than the Romanesque and of greater vigor than the Renaissance. The buildings at Madison, Ind., and Richmond, Ky., are constructed of materials well known in their sections, and it

POST-OFFICE, CLARKSVILLE, TENN. A DESIGN AFFECTED BY THE INFLUENCE OF PICTURESQUE NATURAL SURROUNDINGS.

is hoped that the best quarries of the Pacific slope may furnish stone for the exterior of the buildings now proposed for San Francisco and Portland. It does not often happen that a government building may be consistently picturesque, but in the cases of Paterson, N. J. (where the lot is irregular in shape and there are considerable differences of grades), and of Clarksville, Tenn. (near which runs a broadly sweeping river with precipitous banks in an almost mountainous country), the result could scarcely be otherwise.

Each one of the three influences, climatic, geologic, and historic,

THE UNITED STATES MINT AT PHILADELPHIA, PA. CLASSIC TYPE, CHARACTERIZED BY SEVERITY WITH REFINEMENT.

is often greatly modified by another and very different (but equally important) condition which always confronts the government architect as surely as it does the architect in private practice. This is the element of cost. For instance, although good building stone may be found within reasonable distance of such cities as Lynn, Mass., Saginaw, Mich., or Pueblo, Col., yet the appropriation authorized by congress for the construction of the building may not be sufficient to warrant the use of stone for the entire building, and the architect must adapt his plans to the funds available. The resulting modification in the selection of material, such as the use of brick with trimmings of stone or terra cotta, must affect the character of the design, and, as granite is a more expensive as well as a more intractable material than sandstone, limestone, marble or terra-cotta, the character of the material selected must be given due consideration in determining the choice of a style.

It is hoped that the preceding pages are indicative of the fact that the government is not a mere machine, a soulless corporation, but, in each of its many departments, has at heart the accomplishment of the greatest good to the greatest number, and is, as in the days of Lincoln, a government of the people, for the people, and by the people.

SIX EXAMPLES OF SUCCESSFUL SHOP MANAGEMENT.

By Henry Roland.

PRE-EMINENT SUCCESS OF THE DIFFERENTIAL PIECE-RATE SYSTEM.

FROM the point of view of the Socialist, the paternalist, and the trade unionist, every full-hand-worker in a given trade should receive a fixed and unvarying time-rate wage, regardless of his output; a man should rank as a man simply, and his pay should not be modified or scaled up or down in proportion to his real earning powers as evidenced by his output. The employer producing structures under commercial conditions of which profit and loss form inevitable features is perfectly aware that, of two men working side by side under seemingly similar conditions, one can and does earn vastly more than the other, and the employer finds that this superiority in production enhances the value of the speedy workman in an even greater degree than the actual ratio between his output and that of his slower mate, because of the greater area-production in which the quickness of the worker is the sole factor. Not only does the fast man do more work, but that work is done at a reduced fixed-charges cost, and the intelligent manager discovers that he must greatly increase the pay of the speedy man or decrease the pay of the slow man to make each equally profitable. Under these conditions the piece-rate at once suggests itself as a remedy. The piece-rate stimulates the slow artisan, and justly rewards the quick worker; tends to increase the area output, and lessen the fixed-charges drawback on profits; and fully justifies the extending application of this method of labor remuneration, which is now in evidence among the more extensive manufacturers.

Nothing is of more importance to the manufacturer who hopes that 1897 is to be the first of a series of profitable years than full information regarding such methods of labor management as have proved themselves advantageous through long use by prosperous and important concerns; and in this view it is believed that this paper, carefully prepared from the piece-rate methods of the Baldwin Locomotive Works, the Midvale Steel Company, and the widely-known establishment of Wm. Sellers & Co., will prove of immediate and timely interest.

A piece-rate may be fixed by guess, by experiment, or by analysis. If fixed by surmise, then the rate must in most cases subsequently be made greater or less, because mere guess-work rarely hits the mark. An early changing of the piece-rate is to be avoided, as indicating ignorance on the part of the management's agent, and only generall

change in the prices of the country can justify or excuse a change in a piece-rate which has been continued for a considerable period, except in case of manifestly improved means of construction. If the prices of all other commodities fall, as was the case in the United States from 1866 up to 1892–4, it is but reasonable that the price of labor should also diminish. If new methods or new machines are used which obviously lessen the labor before needed to make a piece, then the rate may justly be reduced. If the workmen increase their pay solely by greater skill and diligence, it is clearly unjust as well as short-sighted to deprive them of the result of their own exertions, and, except in the two cases of a general price-reduction throughout the country, or a lessening of labor through the use of improved means of production, piece-rates must not be changed, if the best results for both employers and workmen are sought. The master desires the most work from the fewest men, and the workman desires precisely the same thing, provided that he himself is one of the efficent few and can be paid in proportion to his real earnings. In a case where, by the action of an unchanging piece-rate, determined by the analytic method, twenty-two men finally came to turn out considerably more than forty-four day-workmen had produced, the efficient twenty-two were perfectly satisfied to be paid only a part of the gains directly due to their own superiority as craftsmen; had the shop made the piece-rate double the day-wage paid formerly to each of the twenty-two men, it would still have been the gainer in cost of plant, maintenance, and space; but very much less than a double day-rate was gladly accepted, and, in general terms, it may be said that a comparatively small advance above the highest current day-wage of his craft will hold the piece-worker.

The establishment of piece-rates by the experiment of making a certain number of the pieces by good day-workers is always most uncertain in its results, because the workman has every motive for making the experimental time great rather than small, and hence it is likely that the experimentally-established rate will be too great.

The analytic method of establishing piece-rates involves the reduction of the total labor to single operation elements, and the possession of an absolutely certain knowledge by the rate-fixer of the shortest time in which each of these operations can be performed. Say, in lathe work, the rate-fixer knows the least possible time in which a certain lathe can finish an inch length of a certain diameter of work twice over with one light roughing and one finishing cut. Knowing this, he can at once make an absolutely safe piece-rate for work of that class to be done on that lathe; or, if he knows how many pounds of metal a certain lathe can cut into chips in a day, he can then fix a rate for work which involves the removal of a large amount of stock.

The analytic determination is naturally followed by the utmost subdivision of labor, as in case of a common nut at the Sellers shops, where nut-tapping, nut-facing, and the finishing of nut sides are made each a separate step with a piece-rate of its own. This subdivision is the more desirable as it necessitates step-by-step inspection, and so immediately fixes the responsibility of bad work. With the unchanging piece-rate, so low that the good workman must make some exertion to reach the current day-pay of his craft, and yet so high that by diligence and wit he can very considerably exceed the best day-pay, excellent results may be obtained through natural selection of workmen; the eager and ambitious workers set the pace for the easy-going and contented souls, who either leave the work or increase their output to avoid constant reminders of their own inferiority. But, if workmen knew that piece-rates are to be reduced so soon as their winning rises notably above good day-pay, all incentive to exertion is removed, and nothing but a cut in the piece-price can increase the output of product. A cut made when men are drawing only good day-pay is always resented, and continued cutting of piece-rates leads to inevitable sulking and indifference to employers' interests,—conditions most unfavorable to the production of low-cost work. In the Sellers and Baldwin shops piece-rates once established are retained. In the Baldwin shops some rates have been unchanged for twenty years, and a man's value in that shop is estimated by the money he draws; the higher he makes his pay, the more valuable he is considered. In the Sellers and Baldwin shops and in the Midvale Steel Works foremen are paid day-rates, and have no way by which they can increase their pay. This does not give the foreman any incentive to extreme exertion, because his own interests are fully served if he keeps his place, and he gains nothing in money by doing more than his routine duties demand. To increase the foremen's interest in the business, they were, in one instance, made gain-sharers, the experiment beginning with a period of rising prices which gave a constant increase in the earnings of these foremen for several years, during which the management believed the gain-sharing plan a pronounced success. The end of the rising market came at last, with the result of a marked decrease in the total gains of the business, and of course a corresponding reduction in the pay of the foremen, who promptly waited in a body on the management, and, in the course of an amicable interview, expressed a unanimous opinion that they could do better than retain their positions. The management suggested careful consideration, and the foremen, after a time, presented a request for a return to fixed-rate payment, each man naming his own terms. All of these individual propositions were accepted by the management without discussion. Inside of a week

after this acceptance, one of the foremen came to the management and asked an increase of the rate he had himself fixed for his own compensation, saying he had acted without sufficient reflection. The management refused the advance in pay, and all of the foremen remain to-day in their places at fixed rates. But labor troubles do not commonly include the foremen, and, while some device by which the most active interest of foremen in the business could be aroused and maintained is much to be desired, this is of far less importance than an effective stimulant to the efficiency of the workmen, who are the immediate factors in cheap production.

While the Sellers and Baldwin shops amply prove the value and entire practicability of the unchanging piece-rate system, it is quite possible that the "differential" piece-rate, devised by Mr. Fred. W. Taylor of the Midvale works in 1883, and put in operation in that establishment under the management of Mr. R. W. Davenport in 1883-4, is superior to any other form of piece-rate pay.

The principal obstacle to the initiation of a piece-rate system in shops accustomed to day-rates only is the supposed difficulty of fixing suitable rates on each of the vast multitude of greatly-differing pieces which together constitute the output of a metal-working establishment. That there is no real difficulty in this matter is proved by the fact that the Sellers shops, which produce a very large variety of machine tools as well as a great amount of specially-ordered work, and the Baldwin shops, building perhaps hundreds of different styles of locomotives, can and do make such rates for each member of their infinitely-varied productions.

The analytic method of rate-fixing is illustrated by Mr. Taylor in the following example of analysis of a planer job.

"*Work Done by Man.*	*Minutes.*
Time to lift work from floor to planer table	——
" " level and set work on table	——
" " put on stops and bolts	——
" " remove " " "	——
" " " piece to floor	——
" " clean machine	——
Work Done by Machine.	
Time to rough cut ¼" deep surface 4" long 2½" wide	——
" " " " ⅛" deep 3 ft. long 12" wide	——
" " finish cut 4 ft. long 2½" wide	——
" " " " 3 ft. long 12" "	——
Total	——

Add —— per cent for unavoidable delays."

It is sufficient evidence of the possibility of accurate piece-rate-fixing by this method to say that it has been in use at the Midvale and Sellers works for many years. At the Midvale it has been in uninterrupted service since its first introduction in 1883-4, with entire satisfaction to all concerned.

The general effect of piece-rates at the Baldwin, Midvale, and Sellers establishments has been to double, and in some cases treble, the output of the plant, increase the yearly earnings of the men, and greatly reduce the piece-cost to the management. Fixed charges of interest, insurance, depreciation, superintendence, trade-soliciting, and so on are nearly constant, regardless of the volume of output; hence an increase in output greatly reduces piece-cost to the management. The following example is quoted from Mr. Taylor's paper:

"COST OF PRODUCTION PER LATHE PER DAY.

"Ordinary system of piece-work.		*Differential-rate system.*	
Man's wages	$2.50	Man's wages	$3.50
Machine cost	3.37	Machine cost	3.37
Total cost per day	$5.87	Total cost per day	$6.87
5 pieces produced.		10 pieces produced.	
Cost per piece	$1.17	Cost per piece	$0.69"

This example is given by Mr. Taylor in illustration of the value of his "differential" or two-price piece-rate system, but it also shows the effect of increased production in lowering piece-cost to the management, even when this increase is accompanied by greatly advanced workman's pay.

The peculiar feature of the Midvale system is the making of two rates for each piece, the low-rate being paid in case of long time used in production, and the high rate in case the production falls within a certain time-limit. For illustration, say, ten pieces of a certain sort have been decided upon by the rate-fixer as the maximum production per day, with a rate of thirty cents per piece, enabling the workman who reaches this probable maximum to earn thirty cents per hour. It is manifestly a loss to the management if the production falls below the maximum rate, and therefore a low price of twenty-seven cents per piece is made, to be paid in case the workman exceeds ten hours in the production of ten pieces. By this device of the "differential," or double-rate, piece-price, the skilful and diligent workman completing ten pieces inside of ten hours is paid $3.00 for his labor; if he completes them in nine hours, he still obtains $3.00, and has a gained hour at his disposal. On the other hand, the workman who uses ten and a half hours to finish the ten pieces receives only $2.70 for his work, and so makes up thirty cents of the time-loss in use of plant to the management, as is just, since this loss is due to the workman's own inefficiency. In point of fact, the time is rarely

exceeded; in one case at the Midvale, out of thirty-six workmen on the same piece thirty-five were inside the time-limit, and obtained the thirty-cent rate, while one fell behind and exceeded the time-limit, and hence obtained only twenty-seven cents for each piece produced. Thus the double piece-rate offers an incentive for a maximum output which the single piece-rate does not contain, and its working effect is to ensure the largest possible production.

Under the simple piece-rate system used by the Midvale previous to the introduction of the double rate, there was one disagreement which resulted in the departure of 12 or 14 dissatisfied men. Under the double rate there has never been the slightest trouble, and it is almost needless to say that the Midvale men do not join trade societies founded on "equal rights and equal pay for all," because the immediate result would be a lowering of their own pay by their own choice, which is a conclusion most unlikely to be reached by the workman.

All the Midvale workmen, including those classed as laborers, are on differential piece-rates, and the effect has been to more than double the output with no increase of plant or material improvement in machines or methods. The laborer's low rate is 15 cents per hour, and his high rate is 18 cents per hour, earned at piece-rates. The machinist's low rate is 27 cents per hour, and his high rate 30 cents per hour, earned at piece-rates. There is also a boy rate, the minimum being 6 cents per hour.

There is evidence in several directions of the great working value of Mr. Taylor's double piece-rate system. First, under its workings the output of the same plant has been doubled, or more than doubled. Second, the men acquiesced in pay reductions in 1888-9, in 1890-1, and again in 1893, the 1893 rates holding unchanged until now.

The Midvale Steel Works now have about 1200 hands, and have been uniformly busy for several years. They were founded by William Butcher, who came here from England and established a small crucible steel work. In 1872 Mr. Butcher had retired from the superintendence which was temporarily in the hands of Mr. Wm. H. Durfee. A year later, with Wm. Sellers as president of the company, Samuel Middleton became superintendent, and the steel making was put into the hands of C. A. Brinley, with R. W. Davenport, now of the Bethlehem Iron and Steel Co., as chemist. Both were young men fresh from the Sheffield school. The following year Middleton died and Brinley became superintent, Davenport succeeding him as steel maker, and as superintendent in 1882. In 1872 and '73 the company was deeply in debt and had about 2000 tons of unsalable steel scrap in the yard. This was worked into rail blooms for the Reading railroad, and the manufacture of open-hearth steel was pushed, the Midvale

having the honor of producing the first open-hearth steel tires, sending out three thousand, none of which failed in service, and thus obtaining a reputation for superior product in that line which is still maintained. The Midvale was also first to produce satisfactory steel railway axles in America; the Pennsylvania Railway sent trial orders to several establishments, and, the Midvale product proving best, constant orders followed. The Midvale was also first to furnish steel gun-forgings for the United States army and navy, and all of these manufactures—tires, axles, and gun-forgings, as well as steel projectiles—are largely and constantly produced. The establishment is enjoying an abundant prosperity consequent upon the high repute of its products.

Under the single piece-rate at the Midvale there was little increase of out-put. As an example of increase due apparently solely to the operation of the double rate, the production of steel tires has increased from 50 or 60 to 140 per day, with substantially the same plant and same methods.

But unquestionably the strongest evidence of the vitality and working strength of the double piece-rate is to be found in the fact that, although Mr. Taylor and Mr. Davenport have been away from the Midvale for a long time, the system continues in force, and is fully as successful in new hands as when under the fostering care of its introducers. It is often the case that details of labor management which give satisfactory results in original hands fail when others attempt to use them, and it seems conclusive proof of actual value when favorable results follow the continuance of an old policy under new management. In the light of these facts of largely-increased out-put without increase of plant, accompanied by perfect satisfaction on the part of the highly-paid workmen employed in producing this low-cost work, it is evident that the operation of the Taylor double piece-rate at the Midvale Steel Works demands the careful study of all superintendents who desire to be fully informed as to successful methods of dealing with labor.

The Midvale has a benefit system, based on a five-cent weekly deduction from the wages of each employee, which gives $5.00 a week during not more than twelve weeks of disability caused by accident in the works, and a 50-cent-per-capita assessment is made in case of death, which amounts to about $600, to which, after five years' service, $250 is added from the benefit fund.

The thanks of readers are due to Mr. William Sellers, Mr. C. A. Brinley, and Mr. Vauclain of the Baldwin Shops, for information courteously furnished for this paper. Personal mention of the Midvale officials who so kindly devoted time to the enlightenment of the writer was expressly forbidden, and is therefore regretfully omitted.

NICKEL STEEL IN METALLURGY, MECHANICS, AND ARMOR.

By Henry W. Raymond.

IT is a rather curious fact that the name given to the metal which, as an alloy with steel, has effected so complete a revolution in modern armor and bids fair to develop possibilities of which the metallurgist of a few years ago had no conception should have been given it originally in derision, owing to the impression that it was but a base ore of copper. Its use in coloring glass and in various alloys, as in German silver, is by no means of modern date, nor is its use as an alloy with iron or steel a new discovery. Piercy's "Metallurgy," published in 1864, devotes several pages to a discussion of the effect and value of its use, and says that Faraday and Stoddart had melted iron and nickel together in several proportions, and found them to alloy well.

It is said of an alloy of steel with nickel, made by Wolf of Schweinfurth, that "it had the aspect and properties of genuine Damascus steel," and that "nickel iron acquired likewise by the process a magnificent damask." Experiments made at the Washington navy yard some years ago with an alloy of nickel and iron produced remarkable results. The addition of one or two per cent. of nickel to cast iron both hardened, and increased the strength of, the metal to a quite unexpected degree.

The supply of nickel, however, was exceedingly limited, and the prices were correspondingly high, which made it too expensive for economical use as an alloy for commercial purposes. Scientists continued experimenting, and both in France and in England there were some who predicted a great future and almost unlimited possibilities for nickel steel.

Public attention, however, was not especially attracted in the direction of the experiments that were being made or the results obtained in this direction, until the publication of a paper read by Mr. James Riley, manager of the works of Tennant & Co., before the Iron and Steel Institute in England in May, 1889.

This may be regarded as the first authoritative statement, by a student and scientist of recognized ability, as to the possibilities of nickel when used as an alloy with steel. The paper also demonstrated that the author's experiments had been prosecuted for a considerable time, and were not yet completed; that what he had already accomplished

was of so much importance that it had led to his employment by certain capitalists to continue the work, and had induced them to take tentative steps towards obtaining control of the nickel-supply of the world; and also—this incidentally—that Mr. Riley had been censured by those interested for having made public such conclusions as he had reached before the plan to create a nickel monopoly had been matured and carried into effect. Men do not create, or try to establish, monopolies for their own amusement. It is worth while, therefore, to glance very briefly at some of the principal facts in Mr. Riley's paper, and ascertain the estimate placed by him upon the results of his investigations.

In regard to the combination of the two metals, he notes that, if the charge is properly worked, nearly all the nickel will be found in the steel, almost none being lost in the slag; that the steel appears to be more thoroughly homogeneous; and that steel properly made will hammer or roll well, whether it contains little or much nickel. He also asserts that the hardness increases with the addition of nickel, until the nickel constitutes about twenty per cent. of the mass, after which further additions tend to make the steel softer and more ductile. The chief advantages in nickel are increased strength and ductility. Steels that are rich in nickel are practically non-corrodible, and those poor in nickel are much better in this respect than steels having none at all. As a possible explanation of the improved qualities possessed by steel when alloyed with this metal, Mr. Riley quotes M. Chernoff's view of steel,—that it is composed of crystals of metallic iron, cemented together by carbid of iron,—and accounts for the extra strength given to steel by nickel by its alloying with this carbid of iron to form a stronger cement. M. Chernoff maintains that the space between the crystals of iron is much more completely filled, and the cohesion between them rendered much more powerful, and that the points of solidification of the cement and crystals are nearer, producing or maintaining a more intimate interweaving of the elements.

This explanation is cited by Mr. Riley as a *possible* one, and not a conclusion which he would fully endorse. His own opinion of the value of the combination is thus forcibly expressed: "In wide range of properties and qualities possessed by these alloys, it really seems as if any conceivable demand could be met and satisfied." Mr. Riley also says that marine and civil engineers and ship-builders would be most interested in the alloys of five per cent. As to the military engineer he says: "There have not yet been placed at his disposal materials so well adapted to his purposes—whether of armament or

armor—as those I have now brought under your notice," and he suggestively adds that, in his opinion, when the best method of treatment has been arrived at, "their qualities for armor will be unsurpassed."

In the discussion which followed the reading of this paper, Mr. Hall, of Jessop & Son, made the somewhat prophetic remark that it had been said that their society was a medium for sending out information to the whole world which their American cousins were the first to adopt.

Chief Constructor Hall of the navy wanted an opportunity to fire at a nickel plate corresponding to those already fired at.

Mr. Carbutt thought that, if armor plates could be cast to the shapes required, it would offer a great future to Mr. Riley.

Mr. Geneg said that the first experiments were made in Paris in 1882 or 1883. The nickel put to cast iron increased its strength, the breaking-strain, and its soundness. Plates six inches thick had been cast with increased resistance.

The president of the society ventured to predict that they would have nickel plates and nickel rivets placed *in situ* and welded up into a solid mass by electricity before the members then present were many years older.

Mr. Riley, in closing the discussion, said that one drawback was always urged against mild steel,—a want of rigidity, or elastic limit. He hoped this alloy improved it. He thought non-corrodibility another important feature.

It will be noticed that in Mr. Riley's paper, and also in the discussion that followed, the use of nickel steel for armor plates is only casually alluded to. Mr. Riley's researches had been directed toward ascertaining the importance and value of the alloy for general commercial use rather than for any special purpose.

The question as to the best armor for our armored ships early attracted the attention of Secretary Tracy, and to it he devoted considerable thought and study. With the failure of the Bethlehem Company to comply with its original contract, the problem of obtaining any armor at all demanded an immediate solution. The manufacture of the immense heavy plates was an entirely new industry in this country, requiring special tools and implements and the investment of a very large amount of capital. Battle-ships were to constitute our naval fighting force; those the secretary had asked for would require heavy armor and a large quantity of it; before making new contracts it was of prime importance to ascertain where and how rapidly we were to obtain it, and also to make sure that what we bought should be, if possible, superior to that in use by other naval powers. The very

tardiness in delivery was perhaps a fortunate circumstance,—although at the time a constant source of worry and anxiety to the secretary,—since it gave time to experiment and to demonstrate which was the best armor plate.

England had not only covered her ships with one kind of armor,—and that the most vulnerable,—but had closed additional contracts for no less than ten million dollars' worth of the same kind. We were saved from premature adoption of armor that would have to be rejected or would be rendered useless by the very next advance step in investigation and invention.

This armor question the secretary regarded as of paramount importance. While seeking information from the manufacturers able to roll steel armor plates as to their possible output, amount of annual delivery, and rapidity of manufacture, he was also seeking information, wherever accessible, as to the experiments of nations and of individuals in this particular direction,—*viz.*, the discovery of a metal superior to steel in certain essential features.

In the early part of July, 1889, the attention of the secretary was called to the paper by Professor Riley. The experiments therein detailed appeared to him so remarkable in the line of developing a superior metal for armor plating, gun metal, construction plates, and projectiles that he considered it worthy of careful investigation as possibly of great value to our new naval force. He brought himself into communication at once with the owners of the mine in Canada which supplied more than four-fifths of all the nickel ore in the world. From them he ascertained that other nations were beginning to awaken to the possible importance of this new alloy for steel as a factor in future armament, and that one or two foreign governments had already offered to purchase the entire output of this Canadian mine at the owners' own price.

About this time the owner of the mine decided to go to Europe to see for himself to what purpose nickel ore was to be applied by those who were so anxious to purchase. A letter from the secretary to our naval attaché in London (Aug. 5, 1889), Lieut. Buckingham, introduced Mr. Ritchie to him as the owner of certain nickel mines, the product of which the department contemplated utilizing, and directed him to accompany Mr. Ritchie on his visit to English and continental manufactures, and to endeavor to ascertain the proportions, uses, and particularly the composition and treatment of the manufacture, of the alloy called nickel steel, and to report in full the results of this investigation.

August 20, 1889, Lieut. Buckingham reported that the English government was not using nickel in armor or guns, and that no com-

pany in England had yet begun to manufacture the metal for commercial purposes, although a syndicate was trying to get control of the patents and of the supply of nickel, and that The Nickel Company in France then controlled the nickel market. Nickel and iron bullets had been adopted by the French for their Lebel rifle, and were also in use in Austria and Switzerland, with a strong probability that they would soon be in use in Germany and England. Lieut. Buckingham's report was a valuable and interesting document. It recorded the important fact—among others—that nickel was being talked about abroad as an ingredient in an alloy to be used for armor plating, and that remarkable results were hinted at as having been obtained already in some minor trials.

Some months prior to this the secretary had decided to have a competitive test of armor plates of American manufacture. However, ample notice and repeated postponements did not secure any plates for the trial. In order, therefore, to properly test armor-piercing projectiles of domestic manufacture, a steel plate had been ordered of Schneider et Cie, at Le Creusot in France. During the absence of Lieut. Buckingham and his party in Europe, the representative of Schneider in this country informed the secretary that definite experiments had been made at their works with nickel-steel armor plating up to nine inches in thickness, and that suitable projectiles tried against it developed extremely valuable qualities in the new alloy. It occurred to the secretary that this would be a good time to make a comparative ballistic test of simple steel and nickel steel; so, on November 26, 1889, an order was placed with Schneider for "one flat and rectangular nickel-steel armor plate, 8 feet long by 6 feet wide and 10½ inches thick,"—the dimensions of the all-steel plate, and happening to be the dimensions of a plate recently tested in England. This brought about a comparison between two plates from the same firm, and also a comparison with results obtained under similar circumstances in England. The American representatives of Cammel & Co., learning of the proposed test, suggested that a compound armor plate be tried at the same time. As this would make the plate test thorough, a complete one was ordered, in accordance with this suggestion, to be ready at the same time as the others.

As the artillery power had been found insufficient at previous trials, it was directed that a velocity greater by one hundred feet should be given to the 6-inch projectile,—the caliber of the gun being the same as in the English trials; and, as former tests had been too restricted to be conclusive, an 8-inch gun was also made ready for use.

The facts as to the now historical armor tests at Annapolis are widely known. The wisdom of the secretary in making so thorough

an examination into the important question of armor plating was thoroughly vindicated.

Summing up the results : the simple steel plate was penetrated, not perforated, through the entire thickness, the point of the projectile extending a slight degree into the backing, and three of the projectiles were thrown out to the rear of the plate. The character of the impact showed a relatively soft metal. Slight radial cracks extended from each of the impacts from one to two inches in length. The nickel-steel plate was penetrated to apparently the same depth ; two of the projectiles remained in the plate, and two were thrown out badly shattered. At the point of impact there were no cracks whatever, and the character of the metal indicated extreme toughness. The reactionary effort of the plate upon the projectiles was more severe in the case of the simple steel plate. The Cammel compound plate was perforated by each of the 6-inch shots, and cracked, and approximately one-sixth of the upper part was blown off, so that the plate was practically destroyed.

There being still some doubt as to the relative resisting capacity of the plates, the secretary ordered a further trial with the larger gun, the projectiles to have the same perforative energy, but the larger diameter tending naturally to produce cracking, which was an important feature to be tested at these trials. In this test the simple steel plate was cracked diagonally to the four corners, and was conclusively put out of the contest as an armor plate.

The Cammel plate was scattered, as some one facetiously observed, "all over the county."

The nickel-steel plate showed no cracks, and the penetration reached only to the rear face of the plate.

The simple was ahead of the compound, and the nickel equally ahead of the simple.

The department, not being committed to any armor, was thus free to adopt the best, which was proven superior to any then afloat.

It was but logical to infer that, in the face of these results,—which had been watched very closely by every naval power,—the attention of European nations would be directed at once toward this new alloy, and steps taken to make sure of a supply, should its extended use seem desirable.

The United States had been the first to demonstrate its superiority, and of necessity must be placed in a position to first reap the fruits of the discovery. With the exception of some unimportant mines in New Caledonia, the visible supply was restricted to the Canadian mines already referred to, owned entirely by American capitalists. The patriotism of its stockholders, which had so long

held out against foreign offers, could not be expected to last indefinitely.

Whatever was to be done to prevent exclusion from participation in the triumphs we had ourselves obtained—*not* to create a monopoly—had to be done quickly. The secretary prepared a statement showing to congress that it was proposed to purchase enough of the nickel ore for the use of the United States in the development of naval material at present in progress, and to own it in the same manner as it possesses for use under similar conditions stores of niter to the extent of eight million pounds. It was not intended to purchase mines, or to go into the mining or smelting business, but only to make certain the obtaining of whatever quantity might ultimately be found necessary.

Further experiments were to be made, and, as the past twenty-five years had witnessed an enormous development in the older systems, a similar evolution might be anticipated in the case of the new alloy. Moreover, its value to the government could hardly be estimated, if the expectations of its friends were realized, and, if not, nickel ore always had a commercial value, and the purchase, therefore, of the right to obtain as much as might be called for could not entail any loss upon the government. In another direction besides that of ordnance it was believed that nickel plate might be of immense service. An experiment was said to have been tried with considerable success years before, as to the value of nickel as an alloy in the metal coating of ships,—to prevent fouling and erosion, two of the chief difficulties steel ships have to contend against.

It was under these conditions and for these reasons that the secretary asked of congress a grant of one million dollars to be expended at his discretion in the purchase of nickel ore or matte. Setting aside all partisanship, and uniting on the patriotic basis of the welfare and the need of the nation, and trusting implicitly in the honesty, integrity, and business capacity of the secretary, congress gave him what he asked for by a unanimous vote,—a proof of confidence of which he might well feel proud, and such as has never been given to any secretary, unless, perhaps, in time of war.

All the nickel used in the armor of our ships has been purchased in the form of matte, and, after smelting, furnished to the manufacturers. American armor is all of nickel steel, and the English naval authorities were compelled to adopt it for their own ships as a result of our successful experiments. France has also begun its use, and, when face-hardened, it gives undoubtedly a greater resisting strength against modern projectiles than that afforded by any other form of armor plate.

As the many valuable qualities of nickel steel come to be more widely known, its use will become much more extensive, and it will receive new applications. Even now it is used largely for parts of machinery, such as shafting, connecting rods, piston rods, etc. If, as asserted, the metal can be cast, cut, drilled, and turned easily and well, it will have a wide application in machinery, especially for use in the parts which are usually kept bright. Its non-corrodibility adapts it admirably to such situations. Handles, levers, wheels, keys, and many minor parts can be made to great advantage from a material like this, which will not rust quickly from the moisture of the hand ; and heavier uses will be found in the working parts of large machinery exposed to unfavorable conditions of drip or atmospheric moisture. The Midvale Steel Works is making the shafting and engine forgings for the two battle-ships, "Kearsarge" and "Kentucky," of nickel steel, and many prominent firms use it for shafts. It is also used for small-arm barrels, and I believe that all the barrels for the United States navy small arms are made of nickel steel. Its use has been advocated for the plating of war-ships in this country, and in time this is pretty certain to be tried. In general, it may be said that it is coming into use for all purposes where a high elastic limit is desirable.

REVIEW OF THE ENGINEERING PRESS

The Largest Reservoir in the World.

THE Metropolitan water commission is about to build the largest storage reservoir in the world, its capacity being no less than 65,000,000,000 gallons, or, according to *Fire and Water* (Dec. 12), "enough to supply the city of Boston for three and one-half years, and four times as much as the capacity of all the existing waterworks reservoirs of that city. Its capacity is twice as much as that of the new Croton reservoir of New York; thrice that of the six reservoirs of Birmingham, England; thirty times that of the Cochituate; and twenty-five times that of Hobbs Brook, of the Cambridge system. It will hold more water than the inner harbor of Boston." This dam is to be built at Clinton, Mass., and the vast volume of water, covering over four thousand acres, will be entrapped and retained by a dam 1,250 feet long (or 20 feet shorter than the Croton dam), 127 feet high above the ground, and 158 feet high above its rock foundation. This dam is, however, not as high as a number of others which retain much less water. The Croton dam has a height of 157 feet above ground and 225 above rock. "To guard against the pressure of the millions of tons of water that will be exerted on the dam, the engineers have made their plans with the greatest care, drawing upon every attainable source of information." The dam will cross a narrow gorge about three-fifths of a mile above the Lancaster Mills, at which point solid rock support for every part of the dam exists. It will be built wholly of masonry, having the same form of cross-section as that of the new Croton dam. Of the 1,250 feet length across the gorge only 750 feet have a depth exceeding 40 feet at high water, and only 270 feet have a depth exceeding 120 feet; "the maximum depth from high water to the rock at the down-stream edge of the dam is 158 feet." The overflow, 450 feet long at the northern end of the dam, is calculated to permit the escape of a rain-fall of eight inches over the entire area of water-shed supplying the reservoir. Some fear exists in Clinton regarding the safety of the town. Should the dam break away, the flood would certainly destroy the entire town of Clinton, and part of Oakland, Boylston, and West Boylston, and would submerge miles of territory on which stands some valuable property, and seven miles of the Boston and Maine railroad. The effect of building the dam is likely to be disastrous upon the town of Clinton in any event. "The Lancaster Mills, Clinton's chief industry, will be crippled,—perhaps removed,—in order that the Metropolitan district may not go dry." Churches, school-houses, and seven square miles of taxable property will be taken, and, altogether, the inhabitants and owners of the property have some cause for worriment. An expensive change in the system of sewerage in Clinton will also be compelled. The uneasiness of the inhabitants has been heightened by a proposed petition to the legislature for permission to increase the height of the retaining wall of the dam by seven feet, which, if it be done, will increase the holding capacity of the dam to 100,000,000,000 gallons.

The Business Wisdom and Responsibility of the Engineer.

THE proceedings of the Purdue Society of Civil Engineering for 1896 contain an address upon this subject, delivered by Mr. W. F. Goodhue, an engineer of ripe experience. The address is free from technicality, and deals with the relations of civil engineering to the great public enterprises of the present time, the emoluments of the profession, and its standing as compared with that of other professions. In particular,—as indicated by the title,—the responsibilities of engineers, and their deficiencies in business training, are made the prominent topics, the lack in business training being assigned as one of the reasons why compensation is less in

this than in other professions involving no greater responsibility. The legal profession is cited as one wherein the rewards for equal acquirements and service very much exceed those received by civil engineers. An interesting case is narrated in detail, wherein a lawyer appointed as a receiver for a western railroad ran it for five years and nearly "ran it into the ground, receiving for his services, by order of court, the sum of $125,000. An engineer employed to practically rebuild the road after all this mismanagement labored six long years at the task, put the road into first-class condition, and received as his pay about $12,000. This was a personal experience of Mr. Goodhue; in citing it, he disclaims any intent to disparage the legal profession, his purpose being to illustrate the generally-recognized value of a lawyer's services, and "the tenacious grasp which a lawyer holds upon all properties which he is called upon to control and manage," which is in striking contrast with the weakness of hold of the engineer, who, working harder than the lawyer, receives only a fair compensation, "and seems to be at all times outside, and never a part, of the business management . . . of the concern he serves so well and faithfully." Reasons for this are found in the fact that engineers narrow themselves down too much to details, instead of leaving these to subordinates; in the fact that they are deficient in knowledge of human nature, and in the tact needed to manage men; and in the fact that they lack business training, and are, as a rule, much too modest for their own good. "So many engineers in charge of work want to see and do everything themselves. They have a great horror of errors and mistakes, and are willing to trust nobody. Their heads are full of measurements, weights, elevations, designs, and all the ins and outs of the work in hand. They are a sort of monomaniacs on the rules of construction, and, for the time being, live and exist upon their work, and have no thought or care for anything else. Timid themselves, they teach timidity to their assistants. . . . They are seldom in the cabinet and always in the field. The lawyer is always in the cabinet and seldom in the field." These habits stand in the engineer's way of acquiring influence and charge of large business interests, which the lawyer so easily gains, and so firmly retains. But not these alone handicap the engineer in the race for worldly prosperity. "The engineer of to-day should be a practical business man, and it is well if he acquire his business training, partially at least, by actual contact with business methods. He should be as well versed in business as are the lawyer, the contractor, and the maker and dealer in materials, as he is brought daily into contact with one or more of these persons." The engineer should also know something of law. A thorough law course would benefit any engineer, but this is not urged as necessary. It is desirable, however, that "the engineer should know enough of business and of business laws to prevent the subordination of himself in his own chosen field of labor." As an example of a thorough-going business man and successful engineer, Mr. Goodhue names the late General Adna Anderson, and gives a very interesting sketch of his character and life-work, based upon personal experience as one of his assistants for a term of eight years. This great engineer, whose achievements form an honorable record in the military and civil history of the United States, "built more miles of railway than any other man in the United States, if not in the whole world." Of him Mr. Goodhue says: "He paid less attention to the routine and minor details of work than any engineer I ever knew." Of him General Sherman said: "He was a man who talked little and met all your expectations." A saying of General Anderson's that "a man without responsibility should be held as an outcast" introduces the topic of responsibility. The wholesome caution not to accept a responsibility unless the right of self-protection goes with it is formulated, and illustrated by an instance of historical interest,—the failure in 1876 of the bridge near Ashtabula, on the Lake Shore & Michigan Southern Railway, and the subsequent suicide of the chief engineer of the road, who neither designed or erected

the bridge, or had anything to do with its acceptance, but who, notwithstanding, allowed it to stand eleven years without protest, or until the combined strain of a burden of snow and the passing of a passenger train finally broke it down and caused the death of seventy-two persons. Here was an assumption of responsibility without the power of self-protection. The circumstances were such that a protest from this engineer would doubtless have caused his discharge. For this reason, or some other, he did not protest, thus placing himself in a position of great hazard, the consequences of which he escaped by a self-inflicted pistol-shot on the night of the day in which the responsibility was fixed upon him by the testimony of the designer of the bridge at the subsequent inquest.

Coal Washing.

IT is not understood by the general public that the fitting of coal for market at mines is now extensively done by a process called "coal washing." Like many other technical terms in use, "coal-washing" will hardly convey to the lay reader an accurate idea of the thing it stands for. Under it are included different modes of procedure, though all have for their object the separation of coal into special sizes, as well as its separation from slate, bone coal, pyrites, and, sometimes, other and less important impurities. In a paper read before the late meeting of the American Society of Mechanical Engineers, Mr. J. N. Schaefer discusses the subject of coal washing, emphasizing its growing importance, and more particularly describing the Luhrig process as applied to bituminous coal. The extent to which substances (principally slate) which go to form ash and pyrites may be removed by washing is exhibited in a table by Mr. Schaefer. An average computed from this table shows that unwashed coal from twenty-nine different localities gives a mean of 11.01 per cent. of ash. The same coals washed give an average of 3.866 per cent. of ash, or a little more than one-third. The table also shows that some coals are much more improved by washing than others. Thus a coal obtained from Comox, Union Bay, B. C., had its 35.5 per cent. of ash, as it was mined, reduced to 8.5 per cent. by washing. The paper under consideration was printed in the transactions of the society at which it was presented, and has been reprinted in *The Engineering News* (Dec. 17). It is explained that a thorough system of washing bituminous coal comprises the careful separation of the coal into different sizes,—No. 1 and No. 2 nut, No. 3 and No. 4 pea, and sludge. The latter is the fine coal which settles out of the water that has been used for washing. After this sludge has been removed, the water may be used again for washing, and so on indefinitely; about a ton of water suffices for washing a ton of coal. In all coal washing the separation of the principal substances to be removed is based upon the fact that they have a greater specific gravity than that of coal. This principle has long been used in concentrating ores. When the coal and its impurities are shaken up in water, the heavier impurities more or less quickly find their way to the bottom, while the lighter coal forms a top stratum. When applied to ores, this process is called "jigging." The best results have been attained by the use of the old Hartz ore jig. "This jig consists in general of a box, divided vertically into two compartments, from the top to a point below the water line. In one of these compartments, a plunger plays up and down. The other compartment is closed near its bottom by a screen. Coal is placed continuously on the screen near the partition, and water is forced into the back of the other compartment below the plunger. The action of the plunger imparts a pulsating motion to the water, which, acting upward through the meshes of the screen, lifts the lighter parts, allowing the coal to flow out of the front of this compartment near the top, while the slates pass out at a point lower down." In the Luhrig system pieces of broken feldspar are placed upon the screen when fine coal is to be treated, which renders more tortuous the passage out of the refuse, and enables the lighter particles of coal to be more thoroughly separated. This is by no means so simple as it at first

appears. "It must be kept in mind . . . that success in coal washing does not depend so much on individual machines and appliances, which can be made in any good machine shop, as it does on the process and the system upon which the whole plant has been built and is operated. The nature of the coal, and the purposes for which it is to be used, must, in every case, be taken into account, and the plant designed accordingly. It follows that every plant is different from others, and imitation of previously-carried-out plans is generally faulty and disappointing. It is, therefore, advisable to place the design of washing plants in the hands of an expert who, by training and experience in this particular line of work, is qualified to so systematize and arrange the plant as to meet existing conditions and produce the best results." An interesting description of a Luhrig plant as designed for a six-hundred-ton daily out-put, and now being built at the Alexandria Coal Company's Crabtree mine, at Greensburg, Pa., is comprised in the paper, facts being given that will be new to many readers, as well as important to those interested in the American coal industry.

How American Electric and Cable Traction Would Meet British Requirements.

THE RAILWAY WORLD for December publishes a communication upon American cable and electric traction, specially considering how far these systems, as carried out in this country, would be adapted to British requirements. The views expressed seem to have been gathered from the personal observations of an intelligent Englishman, who has made the matter a special study during a visit to the United States, and who has devoted much attention to the financial aspect of present methods, and the pecuniary result of recent improvements. He first notes that cable-traction is not making much progress in America, and says that "some of the reasons for this fact are not applicable at all in Great Britain," while the others "are only applicable in a very limited degree." The inference is that, unless other reasons, of equal force, why the cable traction should not progress are found in England, the system should stand a much better chance there against the competition of electric haulage than in the United States. Our own opinion is that no more important cable roads will be built in the United States, except under conditions that practically preclude the employment of other modes of haulage, or where very heavy grades have to be encountered. According to the correspondent of the *Railway World*, there are, however, those who will not concur in this view. He says: "In quite a number of cities I found men who are either officers of electric street railways or are connected with manufacturing companies declaring that cable traction is antiquated, and that it must give way to the trolley wire. On the other hand, men connected with some cable roads, and experts who are independent of any company or system, maintained that now, as in the past, no means of propelling cars is so economical as cables where grades are severe or where traffic is heavy." As a matter of fact bearing upon this point, cable traction on roads in no less than nine important cities in the United States has been set aside, and the trolley system substituted. The conditions in England which favor cable-traction, as compared with the trolley system, may be understood from the statements that cable speeds in America on the great thoroughfares are often as low as in England, while wages are very much higher; that British cable lines with only a fair traffic are capable of earning very large profits; and that a cheaper style of cable construction prevails in England. A contemporaneous development of both cable and electric roads is, therefore, considered more probable in England than in the United States. The system of uniform fare in vogue in the United States, where a passenger may ride one-half mile, ten miles, or sometimes even more, for a five-cent piece would, it is thought, be opposed in England. "A one-penny fare would not pay, and two-pence would be fiercely resisted by all short-distance riders." It is, notwithstanding, very strongly approved by

this English observer. In view of the fact that the suburban trolley roads are solving the problem of over-crowding in American cities, "it remains a fact that high speed and a uniform fare would probably do more for the workingman in England than all the municipal improvement schemes." This suburban passenger traffic is regarded as the beginning of a social revolution, the influence of which will rapidly widen during the next few years.

Gas Producers.

IN a paper read last October before the Civil Engineers' Club, Cleveland, Ohio, and published in the *Journal of the Association of Engineering Societies* for November, Mr. C. L. Saunders claims that "producer-gas is the cheapest artificial fuel gas per unit of heat," and asserts that it "is rapidly gaining recognition among engineers as one of the foremost means of effecting a saving in cost and an improvement in the quality of manufactured articles." He also notes its increased and increasing use in general industry, and classifies as follows the principal processes for manufacturing it which have recently come into extended use:

"(1) Gas processes which are essentially water-gas processes. In these the air and steam are admitted at the top and drawn down through an incandescent bed of fuel by an exhauster.

"(2) Fuel-gas processes, which are combined water- and oil-gas methods, effecting the decomposition of hydrocarbons injected in small quantities at a number of points.

"(3) Gas producers, with water-troughs for bottoms to permit the continuous removal of ashes, either by manual labor or by a screw conveyor.

"(4) Gas producers having revolving bottoms to facilitate the removal of the ash and clinkers, which are discharged continuously over the edge of the revolving bottom into a sealed ash pit beneath, without interfering with the making of gas."

Those who desire to engage in the manufacture of producer-gas, after selecting the process from one or other of the classes enumerated, will next have to consider how to convey the gas to the point of consumption, and the general construction of the apparatus in all its details of flues, cleaning doors, manholes, burn-outs, valves, etc. The author urges that these are not unimportant, because minor, details, and declares that upon judicious attention to them the success of the undertaking will in large measure depend. "Very often," he says, "a superintendent finds that his men have failed him, and that he must depend on green and ignorant hands,"—a contingency that should not be lost sight of in designing the plant. This is as much as to say that a producer-gas plant must be such that, with proper direction, it may be run with help quite unused to the industry. Another element of success is the knowledge of not merely what the coal intended to be used will do in the laboratory, but what may be expected of it in the every-day, regular industry of making the gas with the aid of "cheap and ignorant men unaccustomed to working gas-producers." Particulars of the kind of coal suitable for the industry are given. The paper itself must be consulted for these, but we may quote the general statement that "it should be a coking bituminous coal of good quality, rich in . . . volatile hydrocarbons and with a low percentage of ash." Another essential to highest success is a proper plant for handling coal and ashes.

There follows a classification of coal-handling plants, which contains useful hints to any who may be interested in the progress of the industry financially or otherwise.

A New Departure in Electric Elevators.

A VERY promising invention, made by Mr. H. Russell Smith, of Chicago, is illustrated and described in *Western Electrician* (Dec. 10). The final outcome of this invention, should further experiment verify its practicability, will be a great simplificatjon, and reduction in the number, of the working parts of elevators, particularly those used in tall buildings for passenger service. The inventor has boldly adopted the old principle of the solenoid and core,

meeting the difficulties in a very ingenious manner. If we suppose a solenoid to replace a hydraulic cylinder, and a core to replace the plunger in such a cylinder, —this core being connected with the car by a system of multiplying sheaves in the same way as the plunger of a hydraulic elevator is now connected with the car,— we may thereby comprehend the general idea of this invention. In order to obtain sufficient amplitude of motion in the core, and uniformity of pull, the solenoid is made up of a series of coils supported on a central brass tube in which the core moves, these coils being so connected with a commutator that any number of them may be excited in series, and each successively cut out of the circuit while another is connected in. In this way coils, say, *a*, *b*, *c*, and *d* can be used, and, when *a* ceases to act, a fifth coil, *e*, begins to act upon the core, and so on. The current is reversed, for reverse motion of the core and the connected car, by a second set of brushes under control of the operator. The only working parts which have rotary motion are the sheaves. No dynamos or pumps are required. The necessary current may be taken directly from central-station wires. The details for regulating motion, over-balancing, stopping and starting, and the safety appliances have been worked out in an ingenious way at a large elevator works in Chicago, wherein the apparatus has been made the subject of experiment for a considerable time. As, however, no data of trials are given with the description, it is safe to reserve judgment until these are supplied. The advantages of such an arrangement, if it can be perfected, are obvious, and the difficulties do not seem greater than those which have been successfully overcome in some other electrical engineering work. The progress so far attained justifies, we believe, the view that this new departure has much promise.

The Congressional Library.

A RECENT article which incidentally mentions the subject of roofing, is an illustrated partial description of the new Congressional Library at Washington, D. C. (*Scientific American*, Nov. 14). The roof of this building is of sheet copper, the dome being gilded with pure gold leaf,—a more durable covering than paint, and one which will not need frequent renewal. The style of the building is that of the Italian renaissance. Its reading-room will probably rank among the finest in the world. It is nearly circular in plan, 100 feet in diameter, and 125 feet high, and is surmounted by a noble dome supported by columns of Tennessee, Numidian, and Sienna marbles.

The scaffolds used for decorating the interior of the dome constitute the main theme of the *Scientific American* article. The decoration consists of stucco work in *alto relievo*, and paintings by Edwin H. Blashfield.

The scaffolds used in constructing the dome and in applying this decoration were rotative, guided above by a pintle at the apex of the dome, and resting below upon wheels that worked upon a circular railway extending around the base of the dome. The structure carried by these wheels was a pair of trusses crossing or intersecting at the center, and carrying five separate floor spaces six feet apart, the flooring being supported by horizontal angle-irons which served as floor-beams. By this ingenious device all parts of the interior of the dome were rendered conveniently and safely accessible to the workmen and artists. This well illustrates the fact that modern architecture, as time advances, more and more combines the skill of the engineer with the art of the designer.

The building, with its grounds, occupies an entire square, admitting of artistic architectural treatment on each of the four sides. It is 470 feet by 340 feet in plan, three stories in height, with four interior courts, and is lighted by 2,000 windows.

Other interesting particulars are presented in the article mentioned, the illustrations in which will give a good idea of the construction and operation of the rotative scaffold,—one of the most interesting engineering features in the construction of the building.

Apprenticeship in Machine Construction.

WITHIN a year or so, if our memory is not at fault, complaint was made through the correspondence columns of the *American Machinist* that there is an increasing dearth of skilled mechanics. With reference to this statement, the editor of that paper remarked, in substance, that, if certain shops had been troubled to get such help, it served them right, since they refused to take apprentices, and thus contributed to the very disability of which they complained. The subject seemed of sufficient importance to justify an investigation, which was accordingly instituted by our enterprising contemporary, and in its issue of December 24 the results are presented in tables and in letters from a great many prominent machinery-building establishments and railway systems of the United States. These statements seem to indicate that, if skilled, all-around mechanics are really becoming scarcer relatively to the demand for such workmen, some cause besides the decadence of the apprenticeship system must be sought; for, contrary to a wide-spread belief, these data show that, out of one hundred and sixteen engine builders, machine-tool builders, railroad and locomotive shops, and builders of miscellaneous machinery that have replied to inquiries, nearly seventy-five per cent. yet adhere more or less to the apprenticeship system, and, for the most part, approve it, and find its operation satisfactory. Many also affirm it to be the duty of every machinery builder to take apprentices, and, if this be the fact, the practice, like the performance of all duty, must redound ultimately to the good of the trade.

These letters are from representative establishments, which, of course, adds very much to their value. Though not made a subject of special inquiry, the subject of trade schools, as a substitute for apprenticeship, was alluded to in the circular letter, and an expression of opinion upon this point is given in a number of the replies. Most of those who say anything about them appear to regard the trade schools as a very inadequate substitute, although conceding their general usefulness.

In connection with these replies are printed communications from officers of two trade unions. A letter from Mr. James O'Connell, grand master machinist of the International Association of Machinists, says that one of the planks in the platform of the association is as follows: "To endeavor to secure the establishment of a legal apprenticeship of four years." The reasons for this endeavor are given, and are followed by a defence of trade unions against the charge of arbitrariness in the limitation of the number of apprentices that shall be taught a trade within a certain period of time, this defence containing only the familiar reasons hitherto assigned for such action. A letter from Mr. Martin Fox, chief officer of the Iron Molders' Union, also defends the restriction of supply, and, by implication, approves the system of apprenticeship only when so restricted. Aside from the effect of this restriction upon wages, he alleges that it will make better, because more thoroughly trained, workmen, and he notes an alleged glaring defect in the old apprenticeship system,—to wit, that, under it, apprentices are not properly instructed, but are set adrift upon the world as botch mechanics. We think our contemporary has not overrated the interest that the industrial world will take in this investigation and discussion. It is high time that the future supply of skilled help in the machinery trade and in allied trades should be seriously considered, particularly if the trade-schools are not meeting expectations. We are sorry that this latter point was not made one of the subjects of special inquiry. The public would be glad to know approximately how far these institutions are fulfilling their mission.

Turret Deck Steamers.

THE past few years have been prolific of new types of ships, among which the whaleback is one of the most notable. Since the advent of the whaleback, the so-called turret-deck steamers, the first of which was built at the yard of Thomas Doxford & Sons, at Sunderland, England, in 1893, seem to have served a useful purpose, since the firm named has built thirty-

one of them, averaging a tonnage of 4,300 and is now building one of 6,000 tons. *The Scientific American Supplement* (Dec. 12), in describing this type of vessel, adds that two still larger vessels of this kind, each four hundred feet long, are also being built in the same yard. The description is aided by illustrations, but a general idea of the peculiar features of a turret-deck steamer may be formed from the following outline. The side-plating of this type of vessel is "rounded over with an easy curve, as in the whalebacks, but, instead of being carried clear across to form a deck, it is rounded upward again with a return curve to the level of the upper deck, which is comparatively narrow, and extends flush, and without any shear, throughout the whole length of the ship. A cross-section of the upper part of the ship would present the appearance of a pair of rounded Z-bars, all the advantages of structural stiffness which are claimed for Z-bar shapes being gained by this arrangement." It is claimed that this renders it possible to dispense with much of the interior stiffening required in iron ships of pre-existing models. The aim has been to attain a sort of cross between the whaleback model and that of an ordinary cargo steamer, the whaleback having been designed with a view to reducing dead weight relatively to capacity for cargo. The turret steamer is intended to give "a maximum carrying capacity on a minimum net register combined with light draught." The first one built carried 3,200 tons on a net register of 1,262 tons, and drew eighteen feet of water "The turret decker is provided with a short forecastle deck, and, as the turret-ways do not extend to the bow, these ships have a high free-board forward, and should make good weather when traveling head to sea." The use of joggled plating, now widely adopted in English and continental ship-building, is said to have been introduced by the firm which is building these turret deckers, now built with plates lap-jointed and joggled. The appearance of a turret-deck steamer contrasts poorly with that of the ordinary steamship, but vessels of this type are claimed to be very seaworthy, and—what is much more important in this commercial age—they have proved profitable to owners.

Electrical Distribution.

THE principles of electrical transmission, applying equally to electric lighting, power, telegraphy, telephony, and the technical and scientific problems involved therein, form the subject of a series of articles by Mr. Francis B. Crocker, beginning in *The Electrical World* of December 19. To those familiar with current electrical literature, the name of this writer will sufficiently guarantee the value of the series; it will be well, however, to outline briefly the method of treatment. The fact that methods of distribution have been furthest advanced in connection with electric lighting—this application requiring a more perfect regulation of pressure and current than the other applications named, and also possessing "the advantage of employing practically all the known methods of electrical distribution,"—leads the author to recommend further study of this phase of the subject.

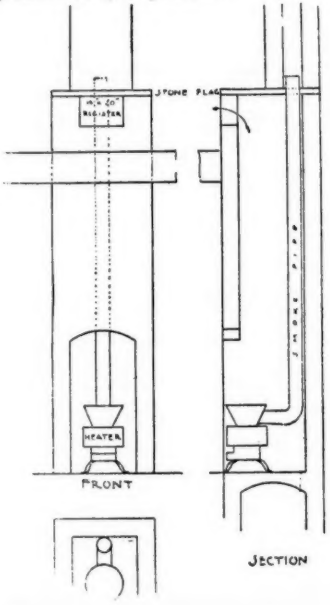
In the first number of the series are treated the measurement of conductors, materials for electrical conductors, electrical resistance, and the standard conductivity of copper. The need of further study becomes apparent from the fact that not only in long-distance transmission, but also "in an isolated electric-lighting plant, the wiring is more expensive than the engines and dynamos combined, even where the maximum distance of the lamps from the generators is only a few hundred feet." This is regarded as surprising; to most of the uninitiated it will be almost startling. American readers will perhaps be gratified that, in discussing the measurement of length of conductors, the foot is made the unit, and that for thickness of wire the American wire-gage (Brown & Sharpe) is the chosen standard. The word "*mil*" (plural, "*mils*") is employed to mean one one-thousandth of an inch, and a "*circular mil*" is the area of the cross-section of a wire one mil in diameter. The area, in circular mils, of any circular cross-section is the square of its

diameter in mils. Thus the area of cross-section of a wire of four mils diameter is sixteen circular mils; for a wire of ten mils diameter, one-hundred circular mils, etc. A comparison of copper with other available conducting materials shows that aluminum is, for a given weight, much superior to copper. A pound of copper wire has for its equivalent 0.56 of a pound of aluminum wire of equal length and resistance. But aluminum wire has the disadvantage that more insulating material is required to cover it, its cross-section being nearly twice the area of that of an equivalent copper wire. In the discussion of resistance,—characterized as "the most important factor in distribution," both from scientific and commercial points of view,—we are confronted with the fact that the cost of copper is the largest item of expense in almost all electrical plants. Whether, or not, this will always so remain it is impossible to say. To reduce this factor of cost, either copper must be more cheaply produced, or some substitute for it must be found. So far, we have no knowledge of any alloys that reduce resistance below, or even down to, the sum of the resistances of their constituent metals when used separately in wires of equal combined weight and length.

Heating and Ventilating Stables.

IN the course of a series of articles on stables, begun in *The American Architect and Builder* (Oct. 10), the author, Mr. C. H. Blackall, describes and illustrates a method of heating a stable of moderate size. Mr. Blackall's style, and the practical character of the series, are exemplified in the treatment of this topic, the cuts of the heating apparatus herewith reproduced.

Premising that the harness-room will be entered directly from out-of-doors (considered the best arrangement, as excluding ammonia and other gases from this room), that its walls and ceiling are sheathed throughout, and that the room is well lighted, having a single drop-light in the center for artificial lighting, the author claims that the heater for the entire stable can best be located in this room. The heater, Mr. Blackall says, has been found very satisfactory in practice.



"The stove, or heater, is set in a recess thirty inches square, formed by eight-inch brick walls on the sides and back, and open in front, the hearth also being of brick though this need not be carried out beyond the line of the brick walls. At a height of five feet above the floor, the front of the recess is closed-in by an arch and the eight-inch brick wall carried up on all four sides to a height of about two feet above the loft floor, where the space is topped off by a horizontal stone flag with a hole cut in the center. Just below this, in one side of the brickwork, can be set a register. The smoke-pipe from the heater is carried up inside of the brickwork and through the stone flag above to second floor, where it terminates, the brickwork above this point being narrowed down to the dimensions of an ordinary flue and carried out through the roof. The radiation from the heater is amply sufficient to heat the harness-room, and enough surplus heat goes up in the brick recess and from the smoke-pipe to supply heat for the man's room in the loft."

THE BRITISH PRESS

A New Departure in Sewage-Treatment.

THE place where this departure has been taken is Sutton, England, and the account of it from which the following description has been prepared appeared in the the *Sanitary Record* (Dec. 11). The experiment was made under advice of Mr. W. J. Dibdin, chemist to the London county council, and by consent of the Sutton urban council. Mr. Dibdin, having come across the minute organism, *Micrococcus candicans*, while analyzing the affluent from a coke-breeze filter-bed,—this organism being known to fatten and thrive on the matter in sewage which, from a sanitary point of view, it is desirable to eliminate,—the idea occurred to him of preparing a bed with these *candicans*, charging it to repletion with sewage, letting the bacteria gorge upon it to repletion, or until they had exhausted the supply, and then examining the resultant affluent. After a mature consideration of this idea, he proposed it to the Sutton urban council as a possible mode of solving the problem of the sewage disposal of large towns, and obtained the privilege of experimenting in one of the settling-tanks, which was set apart for the purpose. A complete system of under-drainage was first laid down, on which was placed a bed of burnt ballast four feet thick, and then water from a filter-bed which contained the micrococcus was pumped upon the bed. The bed was now ready for the reception of the sewage, and was accordingly charged with 25,000 gallons, the full quantity it is designed to hold. No chemicals or lime were used. The sewage was turned in exactly as it came from the sewers, and there left for a couple of hours for the bacteria to do their work. The *Sanitary Record* obtained its information from an article in the *Sutton Advertiser*. Our experience with statements of experimental results as given in American daily papers warns us not to repose too much confidence in their statements of scientific facts, especially such as experts only are competent to judge. We give, however, the results as stated by the paper named the more readily as the *Sanitary Record* appears to give credence to them. The *Advertiser* says that, so far as could be judged from the results, the experiment was entirely successful. The effluent, though not pure enough to be potable, is said to have been certainly much clearer and much better looking than that which comes from the settling-tanks; and it is added that this effluent might, at a pinch, be turned into the stream without any fear of the Thames conservancy inspectors raising any serious objections. It is not intended, however, that this shall be done, the present proposal being that it shall pass through the filters, or over the land, as is done with the other effluent, so that a clear, pellucid stream may flow into the Pylbrook. The process differs from the old plan of passing sewage through burnt ballast, coke-breeze, etc., in order to remove the solids, in that the bed is charged with bacteria before the sewage is turned in, and, instead of there being one continuous stream of foul matter, the charge is allowed to rest awhile after it has flowed in. The process appears to be analogous to the fermentation of the wort in brewing, wherein the action of a rapidly-multiplying organism, contained in the yeast culture, changes the character of the entire mass in a few hours. At present two hours are allowed for the bacteria to do the desired work, and a period of aeration of the same length is then allowed, in order to prevent the bed from becoming choked. The time needed for charging and discharging, in addition to the above, makes it possible to deal with only two charges, or fifty thousand gallons per day, in this one bed. Should permanent success crown this effort,—which, in view of the many failures of processes for sewage-treatment that have preceded it, is yet problematical,—it is said that the council of Sutton will convert all settling-tanks of that town into bacteria beds, and treat all their sewage-

flow in like manner. If successful, the necessity for costly settling-tanks and costly pumping and pressing machinery would be obviated, and it is estimated that bacteria beds for a large town could be constructed for less cost than that of the machinery required at present, while the working expenses would be reduced to a comparatively nominal sum. Of Mr. Dibdin as an expert in sewage-treatment it is said that he "is responsible for the treatment of more sewage than any other man alive," and that his reputation is too high to be hazarded by any practical experiments of the success of which he entertains any doubt whatever.

The Motor Car in 1896.

FOR various reasons we have not said much about motor carriages in these reviews. Regarding this kind of vehicle as in a very early stage of imperfect development, and there being very little to say of results, except by way of recording shortcomings and failures to meet the obvious requirements, we have thought it wiser to use space for more important features of the later nineteenth-century progress. It appears to us that in the Serpollet system the nearest approach to a practical motor carriage has been made, but certainly this is yet very far from being a vehicle adapted to general use as a substitute for wagons drawn by horses. We note that the clumsy and awkward term "horseless carriage" appears to be disappearing from current technical literature. In England, where much effort has been expended to obtain a practical locomotive road vehicle, the term "motor car" is coming into use, and is sufficiently short, convenient, and acceptable. Under the title, "The Motor Car in England in 1896," *The Engineer* (Dec. 4) sets forth the characteristics of the English motor car at the present date. The title indicates a belief that the different makes are so nearly alike in principle as to permit them to be considered as one and the same genus, and the subject is discussed in harmony with this assumption. The position is taken that, had there been no light oil-engine, there probably would have been no motor car at all worth naming. "Petroleum spirit" (as the lighter product of petroleum distillation is called in England) is the agent which, through the labors of many able men (Dugald Clark in particular), has been applied to engines adapted to motor-car propulsion, and has supplanted nearly every other hitherto-tried means for the purpose. Our contemporary truly says: "At the present moment the spirit-propelled motor car is first, and the rest nowhere." But it is predicted that the motor car of 1896 will soon pass into history, as one of the abortions of inventive genius, in an age of mechanical triumphs. What is the motor car of 1896 as it exists in England? "The modern motor car is a vehicle the hind wheels of which are caused to turn round by a petroleum engine. If we come to examine any of these vehicles, we shall find that they are, one and all, constructed on the same general lines as though they were to be drawn by horses. The result is that they are ungainly in appearance. They offend the eye by what they obviously lack. Not a few of the Victorias and four-wheeled dog-carts which are pronounced ugly would look very well indeed if drawn by a good pair of horses. The makers have evidently taken a Victoria, let us say, removed the pole, and fitted a horizontal oil-engine under the body. The two are, as a rule, a very ill-assorted couple. Neither seems to be quite suited to the other. There is not yet in the market—at all events, it has not been seen in England—a thoroughly-well-thought-out-and-designed motor car in which the features of the engine are properly subordinated and harmonized with those of the vehicle. We have heard that in France some vehicles much better than anything yet seen here are being made, and we see no reason to doubt it. The thing is very far from being impossible of accomplishment." The dangers attending a general use of petroleum spirit as an agent for propelling road vehicles are not insignificant. Such a product is more dangerous in storing and handling than gunpowder, forming, as its vapor does by mingling with air in proper proportions, a violently explosive mixture. For this reason alone the

general sale and use of petroleum spirit as an illuminant in households have been prohibited by law. Here, then, is one reason for a belief that the motor car of 1896 will soon become a matter of history. Another reason is the fact that oil, gas, or spirit engines cannot be stopped and started like a steam engine, by merely opening a throttle. They must be assisted by hand in starting, and, as this is practically out of the question in a road vehicle required to make frequent stops, gear for starting and stopping must be interposed between the engine and the wheels of the vehicle. This gear is not so much of a nuisance as the hand labor in starting, but it is far from being an agreeable feature, and the running of the motor constantly when the vehicle is not in motion is an added expense and annoyance. On these and on other accounts *The Engineer* regards the motor car of 1896 as little more than "a gas engine in a cart," connected to the hind wheels and provided with some sort of steering gear. This is very far removed from such a degree of perfection as is necessary to bring motor carriages into general use. We entirely agree with this opinion. Nothing worth speaking of has been done in England in the way of road vehicles driven by electricity, and very little anywhere else. Steam has still a chance, and; we are inclined to believe, the best chance, but, in order to reach any degree of success in a steam-propelled road-vehicle, a radical departure from existing types of road-vehicles must be made. The difficulties in designing a good, commercially-practicable, self-propelled vehicle for public highways are very much greater than they were once thought to be, and a speedy solution of the problem is not at all probable.

Dr. Jacques's Cell.

AN article by Dr. William W. Jacques, entitled "Electricity Direct from Coal," in *Harper's Magazine*, is rather severely criticised by *The Electrician* (Dec. 11). The editor of that paper wields, on occasion, an excoriating pen, and he uses it unsparingly in his treatment of Dr. Jacques's article, or, rather, of the author's claims, since the article itself is characterized as "brightly written and readable," and the cuts illustrating it are alluded to as "telling." But these complimentary remarks are somewhat neutralized by the subsequent imputation that the article is "quasi-scientific," and that, as such, responsibility for it on the part of the publishers of a popular magazine extends no further than to the obtaining of the article from a reputed expert. The article having been "taken on trust" as to its facts, the author is to be held responsible "for anything wrong about it." Doubtless Dr. Jacques is sufficiently capable of replying to the criticisms made in *The Electrician's* editorial, which may be summarized as follows:

Extravagant deductions, the public dissemination of which may do mischief, are implied. The multitude of experiments claimed to have been made by Dr. Jacques are spoken of in a light vein, as though of small account, and the originality of the idea that, "if the oxygen of the air could be made to combine with the coal under such circumstances that the production of heat could be prevented, and at the same time a conducting path could be provided in which a current of electricity might develop, the chemical affinity of the coal for oxygen would necessarily be converted into electricity," is regarded as being confined to the notion implied by the word "necessarily." In Dr. Jacques's attempt to contest the assertion that the current obtained by heating carbon in fused caustic potassa is neither more or less than a thermo-electric current, it is noted that the thermo-electric effect which may arise from the cooling action of the air-blast is passed over without any attempt at refutation. The fact that Dr. Jacques mentions vessels of copper, lead, zinc, tin, aluminum, etc., as being destroyed by the action of fused caustic potassa is assumed to imply that he seriously supposed that vessels of these materials might practically answer the purpose; to demonstrate "ignorance of elementary principles of chemistry"; and to indicate "his degree of fitness for the formidable task of discovering a method

of oxidizing carbon electrolytically." Dr. Jacques's explanation of the reason why, as alleged, vessels of iron used for holding the fused potassa give poor results as compared with those of other metals is called "dreadful nonsense." Without taking up cudgels in defence of Dr. Jacques, we venture to think that the causticity of this editorial will, at least partially, defeat its purpose. Perhaps the writer also thought that it might reflect unpleasantly upon himself, since, as prelude to his remarks, he enters a disclaimer of "prejudice against the deviser of new and unaccepted methods for the direct production of electrical energy," and asks to be believed when he asserts "that the mere manner and place chosen by an inventor for the exposition of his views" do not adversely affect the critic's judgment of the validity of the statements put forth. Whatever may or may not be the value of Dr. Jacques's alleged discovery; however much or little he may be entitled to credit for it,—these facts may surely be discussed without bitterness. Satire adds nothing to, and ridicule subtracts nothing from, a statement that must stand or fall according to its essential merits.

Roofs and Roofing Materials.

EXACTLY what has led up to the active discussion of roofs and roofing materials which has figured so prominently in engineering, architectural, and building literature for the past month, it is impossible to say. Elsewhere we have mentioned some articles on the subject that have appeared in American papers. These, with articles in the *British Architect* (Nov. 13) and the (London) *Architect and Contract Reporter* (Nov. 13), occupy about as much space as commonly could be found devoted to roof-construction in six months' or a year's issues of the papers named.

An abstract of a paper on "Slates," read before the first meeting of The Architectural Association of Ireland, held in Dublin November 11, is contained in the *British Architect*. The author makes mention of some of the chief sources of roofing slates,—America, Wales, Alsace, and France,—and notes some of the qualities of products of different quarries; but he deals principally with the Westmoreland and Cumberland slates. This paper gives an excellent *résumé* of the colors and qualities of slates from the different Westmoreland and Cumberland quarries, the sizes and thicknesses produced, comparative cost of different sizes, etc. With reference to sizes, we note that, whereas there were only three regular sizes fifty years ago,—to wit, twenty-four inches by twelve inches, twenty inches by ten inches, and sixteen inches by eight inches,—there are now some fifteen different sizes, ranging between the extremes of twenty-four inches by fourteen and sixteen inches by eight. This article, written by a practical slater, is full of sound, practical information, and may be consulted with advantage by all who desire reliable, up-to-date knowledge upon the subject of slates and slate-roofing.

Mr. F. Walker read a paper on "Tiles" on the same occasion, of which an abstract is also given in the *British Architect*. One of the points made in this paper is that the power to exclude dampness from dwellings and the power to withstand the disintegrating influence of weather go together in tiles. Density, toughness, and incipient vitrification are the characteristics of good roofing tiles. Tiles of a bright red or of an earthy red are, in general, absorbent, and do not weather well.

A curious and interesting fact relating to old tiles is mentioned by Mr. Walker,—to wit, that in some instances old tiles have been held at a higher market value than new ones, owing to an alleged acquisition of an artificial surface-coating that resists absorption. However, it is probable that esthetic considerations may have had some effect in holding up the prices of old roofing tiles. The best modern tiles are capable of effectually excluding dampness, if laid properly. The highly-fired brindled and blue tiles are most nearly non-absorbent. With reference to laying tiles, the author gives specific and detailed directions of value, but too comprehensive to permit of more than mention here, save in one important particular, relating to roofs of dormers and gables, which in tiled roof-

ing should be given the same pitch as the main roof. If this is not done, purpose-made valley-tiles must be obtained, or resort must be had to lead gutters. Tile-makers keep valley tiles in stock only for roofs whose sides have equal pitch. Some awkward and unsightly results from the use of these stock valley-tiles are mentioned, and a great many other practical and interesting facts relating to tiles and tiled roofs are comprised in this excellent paper.

A third paper, entitled "Copper, Lead, and Zinc as Materials for Roofing," was read at the Dublin meeting by Mr. G. Ewart. Mr. Ewart ably set forth, as among the advantages of these metals, their availability for roofs nearly or quite flat, on which neither slates or tiles could be used. Their comparative lightness is also in their favor. For a given area slates weigh six to seven times, and tiles about fourteen times, as much as copper. Slates weigh four or five times as much as zinc, and tiles eight or nine times as much. Copper and lead roofs are very durable, while zinc occupies an intermediate position. Copper seems to take the lead in this particular. One of the most interesting parts of Mr. Ewart's paper is an account of the condition of some old copper roofs of notable buildings. The tower of the parish church in Hampstead was covered with copper in 1784, and is now in good condition. The copper which had been for two hundred and fifty years on an old church roof in Wiltshire was found imperfect only in the standing welts, which were worn. After trimming off the edges, the struts were relaid. On the whole, copper appears to be a better material than lead, requiring only about one-sixth the weight. It is resistant to fire and atmospheric influences, and requires much less support in ornamental work. It is less expansive under heat, and needs fewer drips. It is easily welted, and acquires a beautiful and permanent color after a few years of exposure.

If the three papers here reviewed are samples of the professional ability of the membership of the new association, it may hope to rank with the best of the architectural societies.

Internal Corrosion of Steam Boilers.

PERHAPS nothing in the whole field of steam engineering has been more puzzling to explain than the internal corrosion of steam boilers. This and that theory have been propounded. Some have supposed that in marine boilers a chemical action is set up, whereby the chlorine contained in the saline matter of sea-water is converted into hydrochloric-acid. Others hold that, if this were the case, at least some small amount of iron chlorid ought to be found in the water of a boiler; but Prof. Lewes declares that this is a substance never met with in water taken from boilers, and so the chlorhydric-acid theory appears to topple over. By far the most widely-accepted theory is that galvanic action is a potent cause, but there are many facts which seem to discredit this belief,—facts ably stated in a paper read before the Institution of Engineers and Ship-builders, in Glasgow last November, and published in *The Engineer* (London, Dec. 4). The author of the paper is Mr. Sinclair Couper, a managing partner in an extensive boiler works in Scotland, whose reputation for extensive study of the subject during a long practical experience in boiler building and repairing, and for careful examination of boilers after use, seems to have been sufficient to call out a notably large and representative attendance at the meeting for which the paper was announced. The theory which supposes galvanic action to be set up through differences in density of the metal was named. It is admitted that in laboratory experiments galvanic action may be set up, from differences in density of the metal and the use of different kinds of metal, as copper or brass, for tubes in iron or steel shells. But, nothwithstanding this fact, too much stress has been laid upon it, Mr. Couper thinks, in the endeavor to explain internal corrosion. We regret that we are unable to even outline this paper in the space at our command. It presents an unusually large array of facts. We can hope to secure for it only a somewhat wider attention than it otherwise might receive, and will note merely one of the many practical points presented in it, —namely, that much of the internal corro-

sion attributed to galvanic action, etc., is really caused by the liberation of free oxygen and free carbonic acid from the feed-water. Heat expels gases from their solution in water, and the gases so liberated attach themselves in the form of bubbles to the interior of the boiler, and act upon the metal at once. It is evident that the author regards this as a potent cause of internal injury to boilers. The corrosion is sometimes local (pitting caused by bubbles) and sometimes general, reducing the thickness of the plates with considerable uniformity. The variety of corrosion called pitting is often met with in feed-water heaters, from which the freed gases cannot escape as they do from a boiler from which steam is constantly being taken. As illustrating this point, the author, exhibited a corroded crown plate and manhole cover of a feed-water heater in which had been used only very pure fresh water taken from Loch Katrine. Where the feed inlet has been placed very low down, a similar action has been noted in steam boilers, particularly if the feed pipes are connected with a part of the boiler wherein the circulation is sluggish; and it is recommended that feed-pipes should be placed near the surface of water in boilers for the avoidance of this action. A very active and common cause of internal corrosion is the presence of fatty acids, sometimes introduced with the feed-water from streams of impure water, but more often passed into the boiler from the engine cylinders, where the oil from which they have been separated has been employed in lubrication. The paper reviews the subject exhaustively.

Combined Sail and Steam Power for Ships.

THE substitution of steam for sails in the propulsion of vessels resulted in the neglect of sail power, and the latter has apparently not received that amount of study as an auxiliary which it might have been profitable to give it. Only in comparatively few instances has steam power been studied as an auxiliary to sail power. A few years ago some vessels were built in the United States for whale-fishing, in which one of the masts was made of steel and hollow, to serve as a smoke stack, and a small auxiliary steam engine was placed on board to assist the sails when needed. This has also been done to a small extent in other countries. But there is no evidence that the problem of combining sail power with steam power in such manner that sails should become a part of the regular propelling power of a ship and an efficient aid to steam was ever made the subject of careful study. Either the sails have been regarded simply as helps to be relied upon only in case the steam engines were crippled or broken down, or, as in the case above cited, the engines have been regarded as helps to be used only when the wind is insufficient and in such emergencies as may arise in navigating seas more or less obstructed by ice. Now Mr. Carl C. Vogt, a Danish marine engineer, makes the propositions, first, that "a special construction of sails is necessary to work efficiently along with steam power"; and, second, that "it is a mistake to build steamers without properly-constructed sails, the greatest mistake of all being to build sailing ships with auxiliary steam power only intended for use in calm weather, because it is just when there is wind that the steam propeller acts to the greatest advantage in connection with properly-constructed sail power." These propositions are enunciated in a paper by Mr. Vogt in *The Steamship* for November, which also contains an account of an experimental study, made by permission of the Danish admiralty, with the frigate Fyer, to test the validity of the theory. The vessel has 2,740 tons' displacement, about 20,000 square feet of sail area (a Danish foot is equal to 1.029 feet English, and a Danish pound is equal to 1.098 pounds English), and 2,600 indicated horse-power of steam. A sample of the mode of investigating the subject follows:

The vessel one day, when moved by steam alone, was advancing at the rate of a little more than five knots, right in the face of a strong top-sail breeze of thirty-two feet per second, with corresponding sea. Her horse power at the time would have given her a speed of 8.5 knots in calm weather. Upon turning the ship 5½ points off from the wind, her speed rose

to eight knots, without any increase of steam power. When gaff and stay-sails, having a total area of six thousand square feet, were put on, the speed rose to nearly ten knots. Comparing this with the horse-power of steam used in the experiment (540 h.p.), the power of the sails working in conjunction with the steam is computed to be 320 h.p. But, when the sails were used alone, the speed dropped to two and one half knots, which corresponds to only thirty h.p.

The difference between the power developed with sails alone, and that developed by sails working in conjunction with steam, was inferred from this to be more than three hundred h. p. The fact is accounted for by Mr. Vogt somewhat as follows: When the sails only were used, the vessel made a great deal of leeway, her sail area being insufficient to propel her at such speed as to effectually reduce leeway. When the steam power coöperated with the sails, there was scarcely any leeway. The making of leeway increases the resistance to forward motion. Mr. Vogt holds that, with sidewinds and winds before the beam, it is a mistake to regard sails as useless at high speed. He also holds that, although the sails of a windmill are generally of incorrect shape, they are, however, more nearly correct than the usual sails of a ship. Thus he compares the gaff sails of the Fyer with windmill sails. "At the mean speed of the wind a windmill of two sails requires an area of sixteen square feet for each horse power, whilst gaff sails, like those of the Fyer, require about thirty square feet at ten knots, and forty square feet at seven and one-half knots, the wind being a little before the beam. An effective horse power requires more than twice as much sail area." We cannot further follow the discussion, which proceeds to consider the application of combined steam- and sail-power to merchant vessels.

Electric Train Lighting and Other English Improvements.

THE compartment system, so long a feature of British railway passenger travel, clung to with a tenacity characteristically English, notwithstanding the deprecation of foreign travellers and critics, is evidently beginning to loosen its hold upon the affections of the English public. First, what the English call corridor carriages, with some compartments, of a size supposed to accommodate six passengers, three on either side when full, were placed on the main lines; but the compartments, when full, are not comfortable, it is said, and it is now announced in *The Electrical Engineer* (Dec. 4) that the South Eastern Railway Company has gone a step further, and has provided "a completely new express train, modelled on the American vestibule type, for the London-Hastings service." The convenience and comfort of this train will lead, no doubt, to a further extension of the system in England, and will much enhance the agreeableness of English railway travelling. It is interesting to note many features on these cars that are of American origin. The heating of the cars is effected by an independent Baker hot-water heating apparatus placed on each car. The ventilation is effected by adjustable louvres with ornamental panels placed between the alcove roof and the upper deck roof. Both in heating and ventilation, therefore, well-known American systems have been adopted. Last, but not least, each of the cars will be lighted by electricity, the current being derived from a dynamo driven by a link belt (another American contrivance) from a pulley on one of the car-axles. A mechanical novelty in the method of driving these dynamos is their regulation by belt-slip. We are not sure that this should not be called an unmechanical novelty, but, if it works well, as is claimed, it matters not what it may be called. Our contemporary describes this arrangement for maintaining a constant voltage independent of the speed at which the train is going, instead of allowing the speed of the dynamo to vary, and regulating the magnetic field, as follows: "The dynamo is suspended so that its weight gives the necessary tension to the belt. The weight of the machine and the torque on the armature then exactly balance each other at normal output. Any

further effort causes the dynamo to be pulled near the driving-axle. This slackens the belt, and allows it to slip over the driving-pulley. Thus a condition of equilibrium is reached, and a further increase of speed is impossible." Below normal speed the current of the dynamo is reinforced by current derived from accumulators. The latter supply all the current during stops. A device is supplied whereby, when the car reverses its motion, —and, consequently, the motion of the driving axle,—the armature connections are reversed also. "An automatic switch, worked by a small governor on the shaft, closes first the shunt circuit and then the main circuit, as the speed increases to the normal," and contrariwise in slowing up. "The accumulators, which are of ample capacity, are placed in two wooden boxes under the carriage. One of these boxes is fixed on each side exactly under the center of the carriage. The lids of the boxes are easily reversed, giving access to the cell. There are sixteen of these to each car, the plates being contained in teak boxes." The current strength from the dynamos is thirty-five amperes at full load, and the lamps are, at a pressure of thirty-five volts, uniformly of ten candle power for each of the cars. Half of the lamps are left burning in the daytime, the surplus current being then used for charging the accumulators. A switch is placed in the attendants' recess, near which a small ammeter enables the current strength to be read at any time.

The "Stone" system of lighting cars, as here outlined, is said to be regarded with favor by railroad men, and to have proved very successful on the new London Hastings train of the Southeastern Railway.

The Rue De Tolbiac Bridge, Paris.

THIS bridge, which forms a viaduct over the Orleans railway in Paris near the terminal station, has peculiarities of construction which render it interesting from an engineering point of view, though it is not a joy forever as a thing of beauty. *The Engineer* (London, Dec. 25) presents a brief illustrated general description of this bridge (supplementary to a former illustrated detailed description previously noted in this magazine) with the remark that, "in point of unsightliness, it can even give odds to some of the British *chef d'œuvres* in that particular line," which is certainly a strong characterization of the inherent ugliness of the design. The bridge has been completed since the first description was published, and seems to meet all requirements except in the respect above mentioned. The prominent peculiarity of this bridge is that, while it has three spans resting upon the abutments and two intermediate piers, each is at a distance of 167 feet from its corresponding abutment,—these piers standing 197 feet asunder, center from center; the middle girders are 276 feet long, or 79 feet longer than the measurement between the centers of the piers that support them. Thus the opposite ends of the girders form cantilevers, each of which supports one end of its corresponding side girder, the other end resting upon the corresponding abutment. Each of these cantilevers projects toward the corresponding abutment a distance of 39½ feet. The central girders are irregular polygons, the bottom string-pieces being a considerable distance below the level of the bridge floor, which therefore shows through the lateral spaces. These lower stringers reach straight across between the central piers and then incline upward to a point somewhat above the floor level at the terminal of the cantilever. The stringers at the top of the girder extend the same distance and then incline downward at a less obtuse angle, to meet the lower part, but not in a straight line, each of these parts having an unsightly hump, the purpose of which is obscure, unless it is a part of a concerted scheme of asymmetry which appears to pervade the entire design. The junctions between the central and the side girders are in the nature of hinge-joints, or pivoted joints, and this principle is also extended to the connection between the main and the cross girders, which are practically hinged—not riveted or bolted—to the main girders in such manner that the ends of the cross

girders may move very slightly in their own plane, according to the loads they are required to support and the degree of flexure to which they are subjected. It is claimed as a special advantage for this method of uniting the main and cross girders that, as it obviates deformation and distortion of the main girders resulting from the transference of loads to them by the cross girders, and as these forces are thus caused to be "purely vertical in character, the bracing is reduced simply to that required for resisting wind pressure." A notable feature of these queerly-shaped girders is the excessive length of panels, "which, in all those belonging to the central span,—except in the end bay or length,—reaches the formidable dimension of forty feet,—a regular girder bridge in itself. The longest diagonal strut—for, with the exception of four, all the inclined members of the web are in compression—exceeds by about a couple of feet a panel-length. These great lengths or bays are sub-divided or halved in the lower boom by the suspension stirrups which connect the upper pieces, where the web bars meet, with the middle points of the lower panels." Instead of the usual lattice bracing, horizontal plates are employed. Those desiring more minute detailed information will find in the two articles above cited all needful particulars.

Effect on Bridges of Motive Power at High Speeds.

THIS subject, having been brought under the consideration of the Association of Railway Superintendents of Bridges and Buildings, was referred to a committee consisting of Messrs. George W. Andrews, J. E. Grenier, and Walter G. Berg, which made its report at the recent meeting of the association in Chicago. The report is published in *The Canadian Engineer* for December, and doubtless will be disappointing to some who were active in initiating the investigation, if a mere compilation of facts and experience previously gained by others can properly be called an investigation.

In sum, the committee report that, up to the present time no positive law of the mechanical action and resultant effects upon bridge structures of motive power at high speeds has been formulated, and that it is impossible to even approximately indicate the injurious effects of quickly moving loads on bridges.

The committee, in effect, confesses ignorance of the quantitative values of increased strains to which bridges are thus subjected. At the same time it expresses the full belief that these effects can be measured, and that instruments can be made that will register them. This assertion, however, is accompanied, with the opinion that, in so broad a field no one committee can ever arrive at conclusions of great value. These statements are made the justification for the compilation embodied in the report as a substitute for the original matter which, the committee seems to think, was expected, since it solicits the indulgence of the association for the deficiency. Classifying attempted determinations of impacts into (*a*) purely theoretical, (*b*) those directed to measurement of the stretch of bridge members during the passage of trains, and (*c*) those directed to the measurement of the deflections of bridge structures as a whole, the committee declares that the theoretical determinations have no interest to the association. Those in class *b* include tests practically limited to European investigations on riveted bridges, which have shown that impacts on such structures decrease, as spans increase, "in a rather uncertain and erratic manner," and that "the impacts in the various members of the same span are a vague function of the moving load required to cause maximum strain in the member considered."

The instrument invented by Prof. S. W. Robinson for accurately measuring center deflections is favorably spoken of, as one means of obtaining accurate information in a general investigation of the subject. Members of the committee made about one hundred tests of the kind included in class *b*. The results are not included in the report, as they are said not to have been "sufficiently positive." The report well indicates the present imperfect knowledge of effects of impacts of moving loads on bridges.

THE FRENCH AND GERMAN PRESS

Basic Steel Rails.

PROFESSOR TETMAIER, of Zurich, has contributed to the *Schweizerische Bauzeitung* a series of articles examining very thoroughly the chemical reactions of the basic steel process and giving the results of his tests of basic steel rails, and the high authority in which he is held with regard to this subject renders these papers of much interest and value.

After examining the chemical reactions which enter into the basic process, Prof. Tetmaier describes the method of examining the structure of steel rails by the process of etching, giving careful instructions as to the cleaning and preparation of the section to be examined, this being substantially the same process that he described at the international congress in Zurich in 1895. The etching solution is composed of 100 grams of sublimed iodine and 200 grams of iodid of potassium in 1 liter of water, the operation taking from two to five minutes. If the etched specimen is to be preserved, it should be protected by a coating of toluol, or damar varnish. According to Prof. Tetmaier, the test by etching shows "that, with proper care as to temperature and final treatment, steel produced by the Thomas process cannot be distinguished microscopically from the most uniform, homogeneous, and flawless bessemer steel."

The etching test reveals the cause of many of the anomalies which appear in tensile tests, particularly as regards extension andcontraction of area. In many cases the etchings also show the reason why soft steel rails often exhibit greater uniformity as well as lesser amount of wear than harder steels under similar conditions. A number of photographic reproductions are given of etched sections of rails of bessemer steel as well as Thomas steel and Martin steel, illustrating the structure in a very clear manner, revealing especially the flaws of liquation and the presence of particles of slag.

The difference in the appearance of the central portion of the rail head and that of the surface which has to bear the wear of the wheels is marked in the etchings, and the chemical analyses of portions of metal taken from the exterior and interior of the rail heads show also a difference in many cases, as appears in a table of analyses of the sections photographed.

The paper concludes with an account of the tests required for Swiss railways, these being a drop test and a bending test, made upon whole rails, a rupture tension test made upon a machined piece taken from the head of a finished rail, and a chemical analysis.

European Grain Warehouses.

FOR some time there have been many complaints about the inadequacy of the facilities for handling and storing grain in Vienna, notwithstanding the fact that Austro-Hungary is one of the greatest grain-producing countries in the world. In order to be able to recommend the best method for overcoming the existing congestion, Herr Inspector Rischer was sent on a tour of inspection recently to see how things were done in other cities.

A generous abstract of his report appears in two recent issues of the *Zeitschr. des Oesterr. Ing. u. Arch. Vereines*, and in it a number of interesting features are found.

Among other things it is shown that the Rhine country can obtain its grain more cheaply from Russia, or even from the United States or Argentina, than from the nearer grain fields of Austro-Hungary, simply because of lack of suitable handling facilities in the latter country. It was to the ports on the Rhine, therefore, that the Viennese inspector turned his attention.

At Mannheim and at Ludwigshafen were found elevators and conveyors, quite American in their appearance. Even the antiquated city of Worms has awakened to modern ideas in the last few years, and half a million dollars have there been expen-

ded on a fine stone elevator, with belt conveyors, electric lighting, etc., all operated by gas engines in the most approved modern manner.

At Mainz the matter of harbor improvements has been actively conducted for the past fifteen years, nearly $2,000,000 having been expended, partly in the construction of docks as well as warehouses; and as recently as 1894 a new fire-proof elevator was constructed, costing over $100,000 for the building and $3 ,,000 for machinery. Here all the machinery is operated by hydraulic power, produced by two steam engines of 80 h. p., which also furnish the electric light.

Cologne is, of course, an important port on the Rhine, being the dividing-point between the navigation of the Rhine steamers and the sea boats, and also being the great railroad frontier station into Germany. In the construction of the great grain warehouse at Cologne the difficulty of constructing dry storage vaults in a water logged soil was encountered, and it was only by the use of inverted arches over the entire foundation, lined with asphalt, that a water-tight cellar was obtained. At Antwerp there are several large elevators of the American type, and more are projected, while the admirable railway terminal facilities, in connection with the complete systems of hydraulic cranes and great series of docks, render this an excellent place for an inspector to pursue his investigations.

In reporting upon the best system for use at Vienna, Herr Rischer points out the differences between that city and those he inspected. Most of the Rhine cities have docks, while on the North sea, with its high tides, these are a necessity. At Vienna the principal obstacle is the rapid current of the river, making it most desirable that boats should be detained as short a time as possible. Hence he recommends at least three bucket elevators for each boat, so that the work of unloading may be most expeditiously performed, while in other respects he simply emphasizes the importance of the construction of modern internal details, belt and screws conveyors, hydraulic machinery, etc.

He was evidently much impressed with the operation of the Fairbanks automatic weighing machines, of which he speaks in admiring language.

It is apparent from this investigation that the grain fields of Hungary are likely soon to have the handicap of inadequate handling facilities removed, and the competition with America and Russia cannot fail to become closer and sharper when the new works at Vienna are completed.

Recent Swiss Turbines.

SWITZERLAND has undoubtedly made an enviable reputation as a country in which water is most successfully utilized, and hence the series of articles in the *Schweizerische Bauzeitung* by Prof. Franz Prásil, of the Zurich Polytechnic, reviewing the turbines and methods of regulation shown at the Geneva exhibition will be read with interest by American engineers.

All the great Swiss makers were represented at Geneva, including the firms of Piccard & Pictet (successors of Faesch & Piccard, who designed the Niagara turbines), Escher, Wyss & Co., Joh. Jak. Rieter, N. Bauhofer, Theodor Bell & Co., U. Bosshard, and the Ateliers de Construction Mécaniques, of Vevey.

A general predilection in favor of horizontal axis wheels is evident from the exhibits, the Girard and the Pelton types predominating. For lower heads, however, horizontal turbines were preferred, and some ingenious modifications of accustomed forms of both types were shown. In all forms, the influence of the demands of electric lighting appeared in the introduction of regulators of a much higher degree of excellence than heretofore attempted. In recognition of the necessity for close regulation of speed without great reduction of efficiency, the governors of the various exhibits form not the least interesting portion of their mechanism. In the vertical wheels the governing systems were nearly all based on a variation of the impinging stream by means of a variable mouthpiece operated by a set of differential hydraulic cylinders controlled by a centrifugal regulator. In order to secure the closest regulation, a differential sys-

tem of lever connections is used, similar to the well-known "Davey" pump valve gear, by which the governor acts directly upon the turbine gate at one point in a lever and indirectly at another point through the medium of a hydraulic cylinder, the two movements opposing each other, and the connection of each acting as the fulcrum of the other.

This latter device is especially well developed in the high-pressure wheel of the Ateliers de Construction Mécaniques, of Vevey, and in the wheel of Messrs. Escher, Wyss & Co., of Zurich. Another ingenious form of regulator is that known as Schaad's "schalt" regulator, made by Messrs. Theodor Bell & Cie, of Kriens.

The principle of the device, the details of which are very skilfully worked out, is that of an independently-rotating member, which is maintained at the uniform velocity which it is desired that the turbine should maintain, and a ratchet connection between this and an adjoining member driven by the turbine. According as the latter gains or loses upon the former, the ratchet pawls which actuate the turbine gates are set in operation.

Among the horizontal turbines the most interesting exhibit is that of the installation of the electric-power station of the city of Geneva at Chévres. The wheels are arranged in pairs upon vertical shafts, the water entering above the upper wheel and below the lower one, and being discharged between them. The wheels themselves are conical in shape, in three sections each, and the automatic regulator acts, by means of differential hydraulic cylinders, upon a conical series of gates controlling the flow to the guide vanes. These wheels operate under a head varying from 28 feet in winter to 15 feet in summer, and, when the installation is completed, it will contain fifteen such turbines, each coupled direct to a two-phase generator of the Erreger type. Each turbine is of 150 h. p., and two sets are already in position.

Altogether, the exhibits at Geneva show the results of the effort of the hydraulic engineers of Switzerland to meet the demand for closer regulation and better adaptability to the present and future requirements, and Prof. Prásil's articles will be found valuable to turbine builders on this side of the ocean, as representing the latest practice of the best and most noted makers in Switzerland.

The Water Works of Bale.

In 1875 the city of Bâle purchased its waterworks from the company by which they had been constructed and operated since 1866, and from that time to the present successive improvements and enlargements have been made, some of which are of especial value and interest.

The source of supply originally consisted of a number of springs situated at Grellingen, in a valley of the Jura, about 15 kilometers distant. The maximum supply thus obtained, limited only by the capacity of the mains, was about 11,000 cubic meters per day, while the minimum has fallen as low as 2,500 cubic meters per day, this latter having been the case after a long drought in 1893.

In order to increase the supply, a steam pumping system was next constructed, taking the ground water from a gravelly water-bearing stratum found at "Langen Erlen," about 9 kilometers from Bâle, and the account of the development of this source of supply given in the *Schweizerische Bauzeitung* may present some points of value for similar plans in this country.

Experimental borings were made in 1878, and, the quality of the water being found satisfactory, an artificial spring was dug, from which a supply of 8,500 cubic meters was obtained in twenty-four hours; and, as this was kept up continuously for two weeks, it was decided to go ahead. Exploration borings showed that this spring drew from a radius of only about 250 meters, which seemed satisfactory.

The steam pumping station was started in 1881, the plant consisting of a pair of coupled direct-acting condensing engines and pumps. The steam cylinders of these engines are 23½ inches bore by 42 inches' stroke, the pump plungers having the same stroke by 10¾ inches diameter. The steam cylinders are provided with admission valves of the poppet type, and "grid-

iron" exhaust valves, while the pump valves are of the so-called "*etagen-ventile*" variety, formed of annular rings arranged in a cone of steps. These engines operate at twenty-five to thirty revolutions per minute, and their united capacity is about 10,500 cubic meters per day.

The increased demand caused several new wells to be sunk between 1886 and 1894, and in the latter year the new water-works, or, rather, the extension, was begun. Instead of repeating the installation of steam pumping engines, it was decided to try gas motors, using "Dowson" gas produced on the spot; and, as the new system has been placed in an extension of the old building, the two systems may be seen in operation side by side. The gas-producers stand in a room corresponding to the boiler room of the older plant, while the engine and its pumps adjoin the original steam pumping machinery.

The gas engine is a double cylinder motor of the Deutz Gas Engine Company's make, the two cylinders facing each other and the fly-wheel shaft lying between them. The cylinders are each 21 inches' bore by 30 inches' stroke, working at 140 revolutions per minute and developing 160 h. p. This engine drives a triple set of pumps, the pump shaft being connected to the engine shaft by a cotton rope transmission consisting of ten separate ropes, each 50 millimeters in diameter. The pump consists of three single acting plungers operated by cranks placed 120 degrees apart, the plungers being each 10 inches' diameter by 27½ inches' stroke, and the shaft making 60 revolutions per minute.

In tests made of the gas-engine plant last April, by Prof. Meyer of Zurich, there was shown a consumption of 0.86 kilograms of coke in the gas-producer for each actual horse power measured in water raised. This, of course, gives the efficiency of the entire plant, including the loss in the pumps. Separate tests of the pumps showed an efficiency of 96 per cent., so that the net effective power of the gas engine was obtained at a consumption of 1.81 pounds of coke per horse power per hour.

In the articles referred to there is much valuable information about the sinking of the wells, together with plans of the plant; the experience at Bâle may be found useful in discussing the introduction of gas motors in water works on this side of the Atlantic.

The Conception of Monumentality.

UNDER the above title, Herr Moritz Helder contributes an interesting essay to the *Zeitschr. des Oesterr. Ing. u. Arch. Vereines*, reviewing the different modes in which the idea of a monument has been expressed in various ages of history. He shows that in the earliest ages the idea of a monument, as such, found its strongest expression, as in Egypt, both in tombs and in temples.

In Greece came the development of the monumental idea of the temple in its highest form, the influence of Greek art extending eastward in the colonies and westward to Rome. In Rome came an expansion of the monument, and we find the idea including all kinds of public works, arches, aqueducts, baths, palaces, all showing the waning influence of the old religion and the growth of materialism. In the east the ancient idea of a monument survived much longer, and from Assyria and Persia to India the temple and the tomb continued to be the objects of monumental art.

In the earlier times of Christianity the Roman influence predominated, but later the temple again became the great expression of the monumental spirit, as the works of the cathedral builders bear witness, until the advent of the Renaissance again brought secular art to the fore.

In modern times the attempts to express the idea of monumentality show an unfortunate tendency to return to the ancient forms of tombs or temples, but the high ideals of ancient times cannot be our ideals, and the attempts of modern architects to imitate the expression of feelings which to-day cannot exist is an injury to the best development of the art. For us the Roman development of works of utility combining the artistic conception of monumentality as well would be a far more truthful, as well as artistic, resolution of the problem.

A Hungarian Industrial Colony.

THE *Oesterr. Monatschrift* gives an interesting account of the industrial colony at Salgo-Tarjan, in connection with the coal-mining industry there. The number of men employed in the Salgo-Tarjan mines at present is about 3,800, and any man who is employed continuously is eligible to membership in the colony, which is practically a coöperative association for the provision of better dwellings, food, and clothing for the members. That something of the sort is necessary will be inferred from the fact that miners receive on an average but 1 florin and 68 kreutzers per day (about 80 cents), and laborers but 70 kreutzers (about 32 cents). The association has a capital of 1,500,000 gulden (about $700,000), and each workman pays into the common fund four per cent. of his wages, for which he receives as sick benefit his medical attendance and 30 kreutzers per day. During the past year the purchases of supplies for the coöperative account exceeded 500,000 florins (about $240,000).

The principal detail of interest, however, is that of the buildings, which are of three types. The earliest of them were built in 1870, and are much like large military barracks, except that they are divided into separate family apartments of two rooms each, a single building containing twenty of these apartments on each of its two floors, and thus accommodating forty families. There are nine of these large buildings, and five later ones of half the capacity, besides twenty one-story houses for two families each. For these accommodations a rent of 42 florins a year is paid, or about $20. The ground is well drained, and the property kept in good condition, and, according to the report of Herr Alois Meissner, from which the above is taken, the condition of the workmen and their families is far better than that of men in similar condition in life in other parts of the country.

Experience with the Fredereau Globes.

THE Fredereau globes for the better diffusion of electric lights have now been before the public for more than a year, and are beginning to be used in some important places. In a recent issue of *La Révue Technique* an illustrated account is given of their application to the illumination of theatres, the illustrations showing the theatre of the Cabourg casino and the theatre at Monte Carlo. The Fredereau diffusers, as is well known, are based on the principle of the Fresnel lighthouse condensing lenses, and are adapted for indoor use with incandescent electric lamps in a most effective manner. It is an understood fact that, with ordinary globes, either a large portion of the light is lost in attempts to reduce the glare, or else people's eyes are injured by the direct rays from the lamps.

At the Cabourg casino the Fredereau globes are so arranged as to cast much of the light upward against the reflecting ceiling, and the result is that, with only about one-half the number of lamps formerly used, the whole house is so well illuminated that a programme may easily be read anywhere. At Monte Carlo the diffusers are placed in the great chandelier, which was formerly most distressing to the occupants of the boxes by reason of the excessive glare. Since the diffusers have been in use, the candle power of the chandelier has been reduced by two fifths without interfering with the effectiveness of the illumination, and the light is diffused generally over the entire auditorium, and the glare in the boxes relieved. In view of the progress which these globes are making in France, we may soon expect to see them in use in this country.

The Exposition of 1900.

ALREADY a portion of the preliminary work for the Exposition at Paris has been allotted, the first contract being that for fencing in the grounds on the right bank of the Seine, near the Pont des Invalides, and the second for grading and foundation work. Two of the French coöperative societies were bidders for a portion of the latter work, but they were decidedly underbid by a private firm which secured the work.

The plans for the new bridge across the Seine have also been submitted, and some local comment upon them will be found on another page.

The Development of Electro-Chemistry.

A VERY full review of the development of the advances in the applications of electricity to industrial chemistry during the latter portion of this century was made by Prof. Dr. Hugo Ritter v. Perger, in an address delivered recently before the Austrian Society of Engineers and Architects, and reprinted in the *Zeitschrift des Oesterr. Ing. u. Arch. Vereines.*

Dr. Ritter v. Perger gives a historical review of the earlier applications of the electric current from the time of Jacobi's discovery of galvanoplasty,—which Oettel calls the beginning of electro chemistry,—referring to Ostwald's history of electro-chemistry, Jahn's mathematical treatment of the subject, and the practical works of Le Blanc, Lupke, Borchers, Arens, and others.

He then takes up the more recent applications, and gives a rapid examination of the later developments of electro-chemistry, particularly with regard to the electric separation of metals, both by electro-decomposition and by the electric furnace.

The article refers also to the changes in metallurgy and industrial chemistry likely to be wrought by the use of natural forces, such as hydraulic power, to generate the electricity, and concludes as follows:

"Within a few years a new art has arisen,—an art of which the extent is so great and the consequences so far-reaching that it is impossible for us to predict the immense changes which the coming century may see in the chemical industry; changes which will be not less momentous in a commercial sense than those which followed the development of the steam engine.

"With the increasing development of water power, industrial centers of a new kind will arise. Coal, that mighty accumulation of power, will be largely replaced by the force of moving water acting upon swift running turbines, as in the past coal was compelled to give up its energy by means of boiler and engine, or gas was harnessed in the gas engine.

"The consequences of this tireless action of natural force we to day can at least partially understand and foresee. The milestones of this eventful century,—photography, spectrum analysis, the production of dyestuffs by organic synthesis, bacteriology, electro-technics,—all these are crowned by the final triumph of the development of electro-chemistry, by no means the least of the advances in the progress of scientific discovery."

The Distribution of Pressure in Piers.

HERR RUDOLF MAYER, of Vienna, contributes a valuable article to the *Zeitschr. des Oesterr. Ing. u. Arch. Vereines*, showing that the customary idea that the pressure of a pier upon its foundation is uniformly distributed over the entire area is subject to revision.

If we imagine the foundation of a pier to be composed of some elastic, yielding material in layers or courses of constantly-increasing area, we see that the weight of the pier would cause the sole of the foundation to bend down in a convex shape, the pressure being at a maximum directly beneath the axis of the pier and diminishing outward in all directions. When the foundation is composed of a rigid material, this diminishing distribution of pressure still exists, and Herr Mayer shows by diagrams the rate at which it diminishes with each course of the foundation masonry. Thus, for a foundation of 10 courses of stone stepping out uniformly from the base of the pier downwards, it is shown that 75.4 per cent. of the load is borne by that portion of the foundation directly beneath the projection of the base of the pier, while 12.3 per cent. is carried by the outer portion.

Following out the same analysis, it is shown that, no matter how deep the foundation is carried, the minimum pressure carried by the lowermost course directly under the axis of the pier is 50 per cent. of the pressure at the top of the foundation.

Finally, the author deduces the law that, for tall piers, the point at which the relative load upon that portion of the foundation which lies directly under the vertical projection of the pier reaches the minimum of 50 per cent. is found at a depth of foundation equal to one-half the height of the pier.

The Pneumatic Pumping of Sewage.

AMONG the matters of interest connected with the industrial exhibition at Berlin the handling of the sewage of the exhibition grounds is worthy of special notice; the following description is extracted from a general article by the engineer, Herr Heinrich Koechlin, in the *Oesterr. Monat. f. d. Oeffent. Baudienst.* for December.

On account of the low level of the exhibition grounds and the high condition of the ground water beneath, a gravity system of sewerage could not be employed, except at very great cost, and, as in the adopted system of sewers the outlet was about five meters above the level of the plateau on which the buildings were placed, it was necessary to use some form of pumpage.

The method employed was that of pneumatic pressure, as this met the local difficulties in the simplest and least expensive manner, and enabled the collector to be of small dimensions with good slopes; the plans of the firm of Erich Merten & Co., of Berlin, were adopted.

Twenty-two ejector stations were constructed each in a pit about 3.5 meters deep, the depth being chosen so as to give a fall to the collectors of one to two per cent. The flow of sewage is collected in each pit in a cast-iron tank, a float in the tank rising as the latter fills; as the float reaches the top, it opens a valve, admitting compressed air, and the contents of the tank are forced through the discharge-pipe. The valves in the inlet and outlet pipes are large flaps, which appear to have given no trouble, the inlet pipes being of glazed earthenware and the discharge of cast iron.

The total capacity of the collectors is about two hundred cubic meters per hour, which is nearly double the actual requirements of the exhibition, since the maximum discharge per day during the months of June and July was only about 3,300 cubic meters. The compressed air for all the collectors was furnished from a central station near the main entrance to the grounds, an air pressure of five atmospheres (about seventy pounds) being maintained by a direct-connected steam compressor. A pair of Cornish boilers, having a heating surface of 60 square meters (646 square feet) each, are also in use, one being for the air compressor and the other for use in connection with the water-supply.

The entire installation seems to have been most satisfactory in operation, and the system appears to be especially well adapted for the temporary use to which it was applied.

An Extensive Train Yard.

THE new train yard at Friedrichstadt, for operation in connection with the railway station at Dresden, in Saxony, is an important piece of railway improvement; the following points concerning it, taken from the *RévueGénérale des Chemins de Fer*, will be of interest. The system is to be composed of sixteen tracks, of which eleven are now constructed and in use, three round-houses, and a most extensive system of switches and turn-outs, the whole aggregating about 76.7 kilometers of track (about 48 miles). The yard is 2,500 meters long by 300 wide, and the total cost is estimated at about 8,000,000 marks. The arrangements for making up the trains is most complete, relieving the station in Dresden and greatly facilitating the entire work. The yard has a capacity for 4,000 cars, although the greatest number yet reached is about 2,500.

Russian Patents.

THE new Russian patent law, among other changes, forbids the granting of patents at all to inventions relating to articles of education, chemical compositions, medical, food, or health preparations, or for trifling improvements in existing inventions; although it is not said by whom the importance of an improvement is to be decided.

The duration of a Russian patent is to be fifteen years, unless terminated by the expiration of a foreign patent on the same invention, and there is a sliding scale of yearly fees during the whole term of the patent, beginning with 15 rubles for the first year and increasing to 400 rubles for the fifteenth year.

Electric Plants for Small Towns.

AN editorial in the *Deutsche Zeitschrift für Elektrotechnik* sounds a warning to the authorities of small towns against the too hasty installation of local electric-lighting plants.

Most towns already possess gas works, and it cannot be assumed that the electric light will entirely displace gas, especially for lighting dwellings of moderate size; hence the electric-light concern must count on the active competition of gas in many places. In large cities the best customers of the electric companies are the theatres, restaurants, great shops, and the like, but these form but a small portion of the life of a moderate-sized town, and even in residences the hours of lighting are by no means so extended as in the large cities.

In considering the introduction of an electric plant, therefore, the character of the place should be taken into careful consideration. If the town is well supplied with manufacturing industries, the demand for light is likely to be greater, while in an agricultural neighborhood, or one in which quiet residences predominate, an electric-lighting venture is likely to prove a disastrous investment.

While the conditions in this country are by no means the same as in Germany, yet experience has taught some dear lessons here also, and the above considerations are not without value.

The New Bridge at Berne.

FOR some time a new high-level bridge has been under discussion at Berne, and in the *Schweizerische Bauzeitung* is given a description of the details of the final designs submitted and the award of the contract, so that the new structure will soon be well under way. It is to consist of a single great iron arch of 112.5 meters' span, and 33.5 meters' rise, springing across the valley of the Aar, with truss approaches connecting with the high plateaus on each side.

The roadway is to be supported on each side by massive piers of masonry, and the magnitude of the work, as well as the constructive difficulties connected with the deep foundations of the piers, renders the subject an important and interesting one.

Three designs were submitted in the final competition, all closely resembling each other, as was necessarily the case from the precise nature of the specifications issued. The perspective views given in the articles referred to show that the bridge will be a most effective addition to the city from an artistic standpoint, as well as a useful one, and that it will not suffer in comparison with the great stone arch of the Nydeck bridge, near by.

The contract was awarded, after some modifications, to the firm of Theodor Bell & Co., of Kriens, and the structural work will be executed by the well-known Gutehoffnungshütte, of Oberhausen, the other competitors being Alb. Buss & Co., of Berne, and the *Societa Nazionale delle officine de Savigliano*, of Turin.

The work is to be completed in 1898, and the total contract price is 1,754,000 francs, or about $350,000. The detailed study of the plans by Herr H. v. Linden, city engineer of Berne, in the articles above mentioned, is very full. The commission by which the competing plans were examined consisted of Col. Edward Locher, well known as the engineer of the Pilatus railway, and professor in the Zurich Polytechnic, W. Ritter, and Conrad Zschokke, the last two being well-known engineers.

Tests on a 160-h.-p. Gas Engine.

SUCH a test was carried out by E. Meyer, of the Royal Technical High School in Hanover, on a power station with coke generators for gas and waterworks at Basel. The low consumption of coal for the work done has caused considerable interest to be taken in the gas engine. The high pressure produced in the engine cylinders, especially if these are large, causes a great strain on the moving parts, thus making the large horse-power gas engine difficult of construction, and, as Mr. Meyer states, not very much more efficient than some good, but small, gas engines. The *Zeitschr. des Vereines Deutscher Ingenieure* gives the results of this work in detail in its issue of October 24.

The Supporting Power of Soils.

THE *Schweizerische Bauzeitung* illustrates a simple apparatus devised by Herr Rudolf Mayer for measuring the capacity of any given soil to support a load, such as the pressure of a pier or foundation.

Briefly, the device consists of a plunger fitting in an open-bottomed cylinder, so arranged that the bottom of the plunger rests upon the ground, while a platen upon the top may be loaded with weights. A large base plate prevents the surrounding earth from being forced up around the plunger, while the depth to which the latter sinks upon the application of a given weight is measured by the rise of a column of mercury, forced by an auxiliary plunger. Closer measurements are made by a micrometer, and various minor details of construction are clearly exhibited in a drawing.

The principal criticism which may be made of this device is its small size. The one illustrated has a plunger of only 20 square centimeters in area, or about 2 inches in diameter, and it seems unlikely that so small an area of any given piece of ground could give results from which any trustworthy conclusions could be drawn. By using similar apparatus upon a large scale, and repeating the observations at many points, doubtless reliable information could be obtained, but even then much would depend upon the care and judgment of the observer.

Portable Petroleum Motors.

AT the Geneva Exhibition a number of petroleum motors were exhibited, such motors being more and more used in Switzerland in printing and other small manufacturing work, such as the making of parts of clocks, watches, and the like.

Among these motors was shown a portable petroleum engine of six horse power, intended for agricultural purposes, the principal advantages claimed being lightness and freedom from destructive explosion. According to *La Révue Technique*, these Swiss motors develop a horse power with a consumption of 400 to 500 grams (0.88 to 1.1 pounds) of crude petroleum per hour.

The Resistance of Ships.

PROF. MARYNIAK, of Lemberg, has deduced a formula for the resistance of ships, based on the theoretical principles of hydrodynamics, using for the determination of the constants the experiments of Froude on the Greyhound. According to the applications given in Prof. Maryniak's article in the *Zeitschr. des Oesterr. Ing. u. Arch. Vereines*, the resulting formula gives results agreeing very closely with the actual determination by speed trials. The mathematical analysis and the detailed examples are worked out in full in the article referred to, which is in the issue for December 4, 1896.

The New Bridge Across the Seine.

OBJECTIONS are being urged against the construction of the new bridge across the Seine at Paris, commonly called the bridge of the exposition, but which, we believe, is to be named the *Pont Alexandre III.* A writer in *La Révue Technique* calls attention to the already obstructed condition of the river, and indeed it would seem that there are already bridges enough. Within the limits of Paris there are now thirty-four bridges across the Seine, of which twenty three span the main stream and eleven cross the narrow channels around the islands of the *Cité*, *Saint Louis*, and the *Cygnes*. In several instances the piers of one bridge are nearly in line with the openings of the one next above, and the action of the current tends to throw vessels directly against the artificial obstructions thus formed, causing many and sometimes serious mishaps.

The commerce traversing the river at Paris is much greater than one would imagine, aggregating 3,400,000 tons in 1895, not including the swift passenger boats which every visitor in Paris remembers as a characteristic feature of the river; and it can well be understood that the interests involved in the river navigation should desire no further obstruction to the channel.

It is proposed to place the new bridge only about 200 meters from the present *Pont des Invalides*, and to make it a single steel arch, hinged at the crown and

springings as was the roof of the Machinery Hall at the exposition of 1889, and as the *Pont Mirabeau*, just completed, is constructed. The bridge is to be 40 meters wide, thus forming a veritable tunnel over the river, and, while there will be no piers in the stream, yet it is urged that this overshadowing arch will be a serious inconvenience to navigation.

La Révue Technique urges that the bridge should be considered from one or the other of two standpoints,—either as a permanent improvement to the city, or merely as an adjunct to the exposition.

From the latter consideration it should not for a moment be permitted to stand in the way of the important commerce above mentioned, while, in view of the former, it is quite unnecessary.

Finally, it is urged that, if the plan for the bridge must go through in its present shape, the scheme should also include a reconstruction of the *Pont des Invalides*, in order to avoid the threatened dangers.

The Mammoth Globe at the Paris Exposition.

THE project of M. Borgel-Court to construct at the Paris Exposition of 1900 an enormous structure in the form of a geographical globe 150 meters in diameter quite casts into the shade both the Eiffel tower and the Ferris wheel. Those who visited the Paris Exposition of 1889 remember the globe there shown, which, however, was only about forty-two feet in diameter, one millionth of the earth's mean diameter, and was intended solely as a geographical exhibit.

The proposed monstrosity, as described and illustrated in *La Révue Technique*, however, is a far different affair. It is to contain upon its five interior floors representations of all the various countries in the world. The visitor is to be transported by electric railways from one country to another in such a manner that, in traversing the interior of the structure, he will practically visit every country on earth (apparently with the exception of Germany), finishing, of course, at a restaurant on the platform on top.

The entire cost of the proposed globe, including the expenses of operation during the exposition, is estimated at ten million francs, but whether or no this extraordinary project will ever be realized we cannot say. The scheme is as yet only on paper, but, when we remember the short time required for the construction of the Ferris wheel, we must not say that the time is too short to insure us safety from this impending nightmare.

Some Belgian Machine Tools.

LA RÉVUE TECHNIQUE gives several illustrations of machine tools made by the establishment of Messrs. Loewe, of Herstal, near Liege, which, if they were not distinctly labelled, would certainly be taken for machines of American make. The planers, shapers, and automatic screw machines are so close copies of the tools familiar to the American machinist that we cannot help wondering if they are not like some others of which we have heard,—"just the same, only one shrinkage smaller"! The *Révue Technique* is evidently of the same way of thinking, although to another end, for the comment is rather as to the influence which the American method of tool-specialization will have upon the future of the machinist himself. "Whether this tendency be for good or evil we are not now prepared to say," the critic proceeds, "but, if the principle is conceded, it is certain that these tools exhibit the highest degree of perfection." The writer, after describing in detail machines with which every American mechanic is entirely familiar, concludes by saying that the success of such an exhibit at the exposition of 1900 is already assured. Admitting the justice of the tribute, we only add that we trust the honors will then be given to the originals, and not to the copies.

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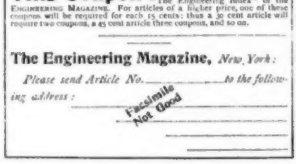
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American Architect, The *w.* $6. Boston.
American Electrician. *m.* $1 New York.
Am. Engineer and Railroad Journal. *m.* $2. N.Y.
American Gas Light Journal. *w.* $3. New York.
American Geologist. *m.* $3.50. Minneapolis.
American Journal of Science. *m.* $6. New Haven.
American Journal of Sociology. *b-m.* $2 Chicago.
American Machinist. *w.* $3. New York.
American Magazine of Civics. *m.* $3. New York.
Am. Manufacturer and Iron World. *w.* $4. Pittsburg.
American Shipbuilder. *w.* $2. New York.
Am. Soc. of Irrigation Engineers. *qr.* $4 Denver.
Am. Soc. of Mechanical Engineers. *m.* New York.
Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
Annales des Ponts et Chaussées *m.* 31 francs. Paris.
Architect, The. *w.* 26*s.* London.
Architectural Record. *q.* $1. New York.
Architectural Review. *s-q.* $5. Boston.
Architecture and Building. *w.* $4 New York.
Architektonische Rundschau. *m.* 18 marks. Stuttgart.
Arena, The *m.* $5. Boston.
Australian Mining Standard. *w.* 30*s.* Sydney.
Baker's Railway Magazine. *m.* $2. N. Y.
Bankers' Magazine. *m* $5. New York.
Bankers' Magazine. *m.* 18*s.* London.
Bankers' Magazine of Australia. *m.* $3. Melbourne.
Berg- und Hüttenmännische Zeitung. *w.* 26 marks. Berlin
Board of Trade Journal. *m.* 6*s.* London.
Boston Journal of Commerce. *w.* $3. Boston.
Bradstreet's. *w.* $5. New York.
Brick Builder, The *m.* $2.50. Boston.
British Architect, The. *w.* 23*s.* 8*d.* London.
Builder, The. *w.* 26*s.* London.
Bulletin Am. Iron and Steel Asso. *w.* $4. Phila.
Bulletin of the Univ. of Wisconsin, Madison.
California Architect. *m.* $3. San Francisco.
Canadian Architect. *m.* $2. Toronto.
Canadian Electrical News. *m.* $1. Toronto.
Canadian Engineer. *m.* $1. Montreal.
Canadian Mining Review. *m.* $3. Ottawa.
Century Magazine. *m.* $4. New York.
Chautauquan, The *m.* $2. Meadville, Pa.
Colliery Engineer. *m.* $2. Scranton, Pa.
Colliery Guardian. *w.* 27*s.* 6*d.* London.
Compressed Air. *m.* $1. New York.
Contemporary Review. *m.* $4.50. London
Dingler's Polytechnisches Journal *w.* 43.60 marks. Stuttgart
Domestic Engineering. *m.* $2. Chicago
Electrical Engineer. *w.* 19*s.* 6*d.* London
Electrical Engineer. *w.* $3. New York
Electrical Engineering. *m.* $1. Chicago
Electrical Plant. *m.* 6*s.* London.
Electrical Review. *w.* 21*s.* 8*d.* London.
Electrical Review. *w.* $3. New York.
Electrical World. *w.* $3. New York.
Electrician. *w.* 24*s.* London.
Electricity. *w.* $2.50. New York.
Electricity. *w.* 7*s.* 6*d.* London.
Elektrochemische Rundschau. *b-m.* 9.50 marks. Frankfurt.
Elektrochemische Zeitschrift. *m.* 18.40 marks. Berlin.
Elektrotechnisches Echo. *w.* 12 marks. Magdeburg.
Elektrotechniker. *b-m.* 12 marks. Vienna.
Elektrotechnischer Anzeiger. *s-w.* 10 marks. Berlin.
Elektrotechnische Zeitschrift. *w.* 20 marks. Berlin.
Elektrotechnische Zeitschrift. *w.* 25 marks. Berlin.
Engineer, The. *s-m.* $2. New York.
Engineer, The. *w.* 36*s.* London.

Engineers' Gazette. *m.* 8*s* London.
Engineering. *w.* 36*s.* London.
Engineering Assns. of the South. Nashville.
Engineering and Mining Journal. *w.* $5. N. Y
Engineering Magazine. *m.* $3. New York.
Engineering-Mechanics. *m.* $2. Phila.
Engineering News. *w.* $5. New York.
Engineering Record. *w.* $5. New York.
Engineering Review. *m.* 7*s.* London.
Eng. Soc. of the School of Prac. Sci. Toronto.
Eng. Soc. of Western Penn'a. *m.* $7. Pittsburg.
Fire and Water. *w.* $3. New York.
Forester, The. *bi-m.* 50 cts. May's Landing, N.J.
Fortnightly Review. *m.* $4.50. London.
Forum, The. *m.* $3. New York.
Foundry, The. *m.* $1. Detroit.
Garden and Forest. *w.* $4 New York.
Gas Engineers' Mag. *m.* 6*s.* 6*d.* Birmingham.
Gas World, The. *w.* 13*s.* London.
Glasers Annalen für Gewerbe und Bauwesen. *s-m.* 20 marks. Berlin.
Gunton's Magazine. *m.* $2. New York.
Heating and Ventilation. *m.* $1. New York.
Ill. Carpenter and Builder. *w.* 8*s.* 8*d.* London.
India Rubber World. *m.* $3. New York.
Indian and Eastern Engineer. *w.* 20 Rs. Calcutta.
Indian Engineering. *w.* 18 Rs. Calcutta.
Industries and Iron. *w.* £1. London.
Inland Architect. *m.* $5. Chicago.
Iron Age, The. *w.* $4.50. New York.
Iron and Coal Trade Review. *w.* 30*s.* 4*d.* London
Iron & Steel Trades' Journal. *w.* 25*s.* London
Iron Trade Review. *w.* $3. Cleveland
Jour. Am. Soc. Naval Engineers. *qr.* $5. Wash.
Journal Assoc. Eng. Society. *m.* $3. St. Louis.
Journal Franklin Institute. *m.* $5. Phila
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. Assoc. *q.* $2. New London.
Journal Political Economy. *q.* $3. Chicago.
Journal Royal Inst. of Brit. Arch. *s-q.* 6*s.* London
Journal of the Society of Arts. *w.* London.
Journal of the Western Society of Engineers. *b-m.* $2. Chicago.
Kansas University Quarterly. *qr.* $2. Lawrence, Kan.
La Nature. *w.* 24.50 francs Paris.
La Révue Technique. *b-m.* 28 francs. Paris.
L'Eclairage Electrique. 60 fr. Paris.
Le Génie Civil. *w.* 45 fr. Paris.
L'Électricien. *w.* 25 fr. Paris.
Le Moniteur des Architectes. *m.* 33 francs. Paris.
Locomotive Engineering. *m.* $2. New York.
Machinery *m.* $1. New York.
Machinery. *m.* 9*s.* London.
Manufacturer's Record. *w.* $4. Baltimore
Marine Engineer. *m.* 7*s.* 6*d.* London.
Master Steam Fitter. *m.* $1. Chicago.
Mechanical World. *w.* 8*s.* 8*d.* London
McClure's Magazine. *m.* $1. New York.
Metal Worker. *w.* $2. New York.
Mining and Sci. Press. *w.* $3. San Francisco.
Mining Industry and Review. *w.* $2. Denver.
Mining Investor, The. *w.* $4. Colorado Springs.
Mining Journal, The. *w.* £1. 8*s.* London.
Monatsschrift des Württ. Vereines für Baukunde. 10 parts yearly. 3 marks. Stuttgart.
Municipal Engineering. *m.* $2. Indianapolis.
National Builder. *m.* $3. Chicago.
Nature. *w.* $7. London.
New Science Review, The. *qr.* $2. New York.
Nineteenth Century. *m.* $4.50. London
North American Review. *m.* $5. New York
Oesterreichische Monatsschrift für den Oeffentlichen Baudienst. *m.* 14 marks. Vienna.
Physical Review, The. *b-m.* $3. New York.
Plumber and Decorator. *m.* 6*s.* 6*d.* London
Popular Science Monthly. *m.* $5. New York
Power. *m.* $1. New York.
Practical Engineer. *w.* 10*s.* London.
Proceedings Engineer's Club. *q.* $2. Phila.
Proceedings of Central Railway Club.
Pro. of Purdue Soc. of Civ. Engs. *yr.* 50 cts. La Fayette, Ind.
Progressive Age. *s-m.* $3. New York.
Railroad Car Journal. *m.* $1 New York.
Railroad Gazette. *w.* $4.20. New York.
Railway Age. *w.* $4. Chicago.
Railway Master Mechanic *m.* $1. Chicago.
Railway Press, The. *m.* 7*s.* London.
Railway Review. *w.* $4. Chicago.
Railway World. *m.* 5*s.* London.
Review of Reviews. *m.* $2.50. New York
Safety Valve. *m.* $1. New York.
Sanitarian. *m.* $4. Brooklyn.
Sanitary Plumber. *s-m.* $2. New York
Sanitary Record. *m.* 10*s.* London.
School of Mines Quarterly. $2. New York.
Schweitzerisches Bauwesen *w.* 20 marks. Zurich.
Science *w.* $5. Lancaster, Pa.
Scientific American. *w.* $3. New York
Scientific Am. Supplement. *w.* $5. New York
Scientific Machinist. *s-m.* $1.50. Cleveland, O.
Scribner's Magazine. *m.* $3. New York.
Seaboard. *w.* $2. New York.
Sibley Journal of Eng. *m.* $2. Ithaca, N. Y.
Southern Architect. *m.* $2. Atlanta
Stahl und Eisen. *s-m.* 20 marks. Dusseldorf.
Stationary Engineer. *m.* $1. Chicago.
Steamship. *m* Leith, Scotland.
Stevens' Indicator. *qr.* $1.50. Hoboken.
Stone. *m.* $2. Chicago
Street Railway Journal. *m.* $4. New York.
Street Railway Review. *m.* $2. Chicago.
Technology Quarterly. $3. Boston.
Tradesman. *s-m.* $2. Chattanooga, Tenn
Trans. Assn. Civil Engs. of Cornell Univ. Ithaca.
Trans. Am. Ins. Electrical Eng. *m.* $5. N. Y.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* $10. New York
Transport. *w.* £1. 5*s.* London.
Western Electrician. *w.* $3. Chicago.
Western Railway Club, Pro. Chicago.
Wiener Bauindustrie Zeitung. *w.* 27 marks. Vienna.
Wisconsin Engineer. *yr.* Madison, Wis.
Yale Scientific Monthly, The. *m.* $2.50 New Haven.
Zeitschrift des Oesterreichischen Ingenieur und Architekten Vereines *w.* 53 marks. Vienna.
Zeitschrift des Vereines Deutscher Ingenieure. *w.* 32 marks. Berlin.
Zeitschrift für Elektrochemie. *s-m.* 16 marks. Halle, a. S.
Zeitschrift für Elektrotechnik. *s-m.* 16 marks. Halle a. S.
Zeitschrift für Elektrotechnik. *s-m.* 20 marks. Vienna.
Zeitschrift für Instrumentenkunde. *m.* 20 marks. Berlin.

ARCHITECTURE AND BUILDING.

CONSTRUCTION AND DESIGN.

9656. The Stimulus of Competition in Architectural Construction. Dankmar Adler (Showing the function of architecture and how departure therefrom may work ill to industry and commerce). Eng Mag —Jan. 3,300 w. 30 cts.

9772. Repairing and Reinforcing Foundation Piers (Describes work found necessary in a recently constructed large office building in New York. Illustrations are given and methods explained). Eng Rec —Dec. 12, 1896. 1,200 w. 15 cts.

9775. Structures Over the Eastern Ends of Some English Churches, and Suggestions They Offer for Modern Treatment (Discusses suggestions that have been offered in explanation of this feature, with illustrated description of examples). Builder—Dec. 5, 1896. 2,000 w.

9776. Trussed Roofs. F. E. Kidder (The writer proposes to describe the different methods of supporting roofs by trusses, the mechanical principles involved in the construction of trusses, the way in which the stresses and size of the pieces are determined and how they should be put together. Illustrated). Arch & Build—Dec. 12, 1896. Serial. 1st part 2,500 w. 15 cts.

9777. Dangers of the Sky-scrapers. Extract from N. Y. Sun (Chief Bonner's explanation of his opposition to high buildings before the committee appointed by the Board of Trade and Transportation). Arch & Build—Dec. 12, 1896. 1,600 w. 15 cts.

9789. The Proposed New Government Offices. H. Heathcote Statham (A criticism of public buildings erected in England, and attributing most of the blunders and mistakes to imperfect understanding on the part of Parliamentary committees). Fortnightly Rev—Dec., 1896. 6,000 w. 45 cts.

9820. Grain Storage Warehouse (Ueber Speicher und Umschlags-Einrichtungen). Paul Kortz (Two articles containing the substance of a report of Herr Anton Rischer, City Inspector of Vienna, after an inspection of the various systems of grain handling and storage in various cities prior to local improvements. Accounts are given of the methods used in Ludwigshafen, Mannheim, Worms, Frankfurt, a. M., Mainz, Köln, Duisberg, a. Rh. Ruhrort, Uerdingen, Antwerp, London, Liverpool and Budapest. A most interesting account of Continental systems). Z. Oesterr, I. u. A. V.—Nov. 27 and Dec. 4, '96. Both articles 10,000 w.

9825. The Laws of Buckling for the Most Important Materials of Construction (Die Gesetze der Knickungsfestigkeit der Technisch Wichtigsten Baustoffe). Ingenieur Paul. (Formulae for the resistance of long and short pillars of various materials, based upon the recent experiments of Prof. L. v. Tetmaier, at the Zurich Polytechnic). Z. Oesterr, I. u. A. V.—Nov. 27, '96. 1,500 w.

9828. Architecture. An essay, with reference to the Geneva Exhibition (Exposition Nationale Suisse à Genéve. Essai d'Architecture). M. Louis Viollier. (A discussion of the relations of the artistic and constructive sides of architecture, suggested especially by the Geneva Exposition. Two plates of interiors). Schw. Bauz—Oct. 3 and 10, '96. 1,500 w.

9829. New Evangelical Church at Wiedikon-Zurich (Die Neue Evangelische Kirche in Wiedikon-Zurich). Paul Reber. (Description, with plate and cuts). Schw. Bauz—Dec. 5, '96. 1,000 w.

9830. New Secondary School House in Zurich (Das Neue Sekundar Schulhaus in Zurich). A description, with plate of an excellently arranged school house in probably the best educational centre in Europe). Schw. Bauz—Dec. 12, '96. 800 w.

9831. The New Palace of Justice at Budapest (Der Neue Justiz-palast in Budapest). A brief description, with plate and plans of the rather showy design of Prof. Haussmann, commenced in 1893 and finished last August). Arch. Rundsschau. —Nov. 2, '97. 500 w.

9832. Apartment House in Vienna (Zinshaus in Wien). Ign. Sowinski (Plate, plan and brief description of an apartment house in the modern showy Viennese style). Oesterr. Monatschr. f. d. Oeff. Bau—Dec., 1896. 200 w.

9834. Concerning the Computations for Beton-Iron Construction (Ueber die Berechnung der Béton-Eisenconstructionen). J. Melan (A valuable mathematical treatment, taking into account the relative elasticity of iron and beton, and written by the inventor of this much-discussed system of construction). Oesterr. Monatschrf. f. d. Oeff. Bau—Dec., 1896. 3,500 w.

9836. The Conception of Monumentality. (Ueber den Begriff der Monumentalität). Moriz Heider. (An essay showing the different ideas which existed in successive ages as to the proper expression of the idea of a monument and criticising the present treatment of the subject.

9842. The Tomb of Ibrahim Adil, Shah of Bidschapur. (Grabmal des Ibrahim Adil Schah zu Bidschapur). (Perspective sketch and detail of a Hindû tomb of the mosque order). Zeitschr. d. Oesterr. Ing. u. Arch. Vereines—Dec. 25, '96. 800 w.

9849. The Tower of the World at the Exposition of 1900. (Le Tour du Monde

à l'Exposition de 1900.) (An illustrated description of the monster globe which it is proposed to construct to outdo the Eiffel Tower). La Révue Technique—Nov. 10, '96. 2,500 w.

9932. The "Standard" Buildings, Calcutta (A short description of a beautiful piece of architectural engineering, with illustrations). Ind & East Eng—Nov. 14. 1,300 w. 45 cts.

10023. The Underpinning of Heavy Buildings. Jules Breuchaud (Illustrated description of a novel method recently adopted for the support of heavy buildings. The foundation work for the Commercial Cable Building, twenty-one stories high, at Broad and New sts., New York City, is described, with the method for preventing damages to adjacent buildings). Am Soc of Civ Engs—Dec., 1896. 2,700 w. 45 cts.

10042. The Structural Framework of the Astor Hotel, New York City (Illustrated description of the principal details of the structural work of the new Astor Hotel, now being erected at 5th ave. and 34th st.; also editorial). Eng News—Dec. 24, 1896. 4,000 w. 15 cts.

10053. High Buildings (Objections as presented in discussion before the Board of Trade). Fire & Water—Dec. 26, 1896. 1,800 w. 15 cts.

10086. The Great Mosque of the Omeiyades, Damascus. R. Phene Spiers (Illustrated description of the actual buildings of the Mosque and their adjuncts as they existed prior to the fire of 1893; a brief sketch of the history of Damascus so far as it relates to these buildings, with a research into the dates and original plan of the earlier remains, and some account of the damage done by the last fire). Jour of Roy Inst of Brit Arch—Nov. 19, 1896. Serial, 1st part. 7,500 w. 30 cts.

10116. Construction Details and Testing of a Fireproof Floor System. A. L. A. Himmelwright (Illustrated description of construction and tests of the Roebling floor system). Eng Rec—Jan. 2, 1897. 2,500 w. 15 cts.

10117. The Regulation of Tall Building Construction (Summary of the regulations in force in the cities of Continental Europe regarding the limitation of the height of buildings, as submitted by President Wilson to the Board of Trade and Transportation of New York City). Eng Rec—Jan. 2, 1897. 1,200 w. 15 cts.

10122. Model Apartment Houses (Drawings of accepted designs to be built by the City and Suburban Homes Company, with description). Arch & Build—Jan. 2, 1897. 900 w. 15 cts.

10158. Oxford Municipal Buildings (Brief record of the materials employed by the architect in the construction). Brit Arch—Dec. 18, 1896. 1,800 w. 30 cts.

10161. Steel Skeleton Construction (Abstract of paper read at meeting of Civ. Engs., England, by E. C. Shankland on "Steel Skeleton Construction in Chicago"). Col Guard—Dec. 24, 1896. 1300 w. 30 cts.

10186. St. Joseph's College, Colombo (Illustrated description of the Roman Catholic College in Ceylon). Ind Engng—Dec. 5, 1896. 1,500 w. 45 cts.

10207. Model Lodging-Houses for New York (Brief description of great improvements in this class of buildings in Glasgow, Manchester, London and other European cities, and now being made in New York. Illustrations of designs of Mr. Ernest Flagg now being built by Mr. D. O. Mills). Rev of Revs—Jan., 1897. 1,500 w. 30 cts.

10290. Pneumatic Caisson Foundations for the Gillender Building, New York City (Illustrated description of an interesting foundation work recently erected at the corner of Wall and Nassau sts., N. Y.). Eng News—Jan. 7, 1897. 1,500 w. 15 cts.

HEATING AND VENTILATION.

9686. Ventilation Practically Considered (An extract on the heating of school buildings from a work published by Rufus R. Wade). Met. Work—Dec. 12. 3,800 w. 15 cts.

9920. Heating and Ventilation of the Atchison, Topeka and Santa Fe Railway Hospital (Illustrated description of the building and its fan system of heating). Heat & Ven—Dec. 15. 900 w. 15 cts.

9921. Ventilating and Warming Stables (Considers the proper area of floor space for stables and also the cubic space, and the quantity of fresh air required both summer and winter). Heat & Ven—Dec. 15. 1,800 w. 15 cts.

9922. The High Pressure System of Heating in England. Frederick Dye (Explains the system which, in England, is considered for certain purposes to excel all others). Heat & Ven—Dec. 15. 1,800 w. 15 cts.

9944. Heating and Ventilation of the Central High School, Detroit, Michigan (Illustrated description). Eng Rec—Dec. 19. 1,800 w. 15 cts.

10045. Heating and Lighting with Mineral Oils. Dr. Stevenson Macadam (Abstract of paper read at the Royal Scottish Soc. of Arts. Discusses the dangerous character of oils, to what due, and the requirements for safety). Arch, Lond—Dec. 18, 1896. 1,800 w. 30 cts.

10119. Heating of a Medford, Mass., School (Illustrated description). Eng Rec—Jan. 2, 1897. 1,200 w. 15 cts.

10136. The Warming of Buildings by Hot Water. Ernest King (Read before Inst. of Junior Engs. Part first considers the low-pressure system, in which the water in the apparatus is at one or more points open to the atmosphere).

Prac Eng—Dec. 25, 1896. Serial, 1st part, 1,000 w. 30 cts.

LANDSCAPE GARDENING.

9731. Landscape Engineering in Connection with an Engineer's General Practice. W. K. Eldridge (Showing how the study and thorough knowledge of landscape design and management is helpful to the engineer). Purdue Soc of Civ Engs—1896. 5,500 w. 45 cts.

10087. Landscape Effects at Kew. W. W. (An account of the picturesque scenery produced in this botanical garden. Illustration). Gar & For—Dec. 30, 1896. 700 w. 15 cts.

10204. The Planting of Shrubberies (Editorial commending a pamphlet issued by Prof. Bailey of the Cornell Experiment Station, entitled "Suggestions for the Planting of Shrubbery," and commenting briefly on the subject in general). Gar & For—Jan. 6, 1897. 1,200 w. 15 cts.

PLUMBING AND GAS-FITTING.

9712. Construction of Drains E. C. Lynde (From a paper read before the Incorporated Assn. of Munic. & Co. Engs. Deals with improved methods of drainage construction). San Plumb—Dec. 1. 1500 w. 15 cts.

9713. Gas-fires and Gas-stoves. W. Grafton (Discusses some of the principles involved in the manufacture of gas-fires, and where to look for failures should they occur). San Plumb—Dec. 1. 1,700 w. 15 cts.

10120. The Hefner Standard Lamp (Conditions of test of the lamp, with its description in the form in which it is admitted to standardization, &c.). Pro Age —Jan. 1, 1897. Serial 1st part. 2800 w. 15 cts.

10143. The Process of Lead Burning. G. A. S. (Gives history and advantages of the system and describes the process. From "The Building World"). Dom Enging—Dec., 1896. 900 w. 30 cts.

10144. House Plumbing. Henry N. Ogden (Read before the Tompkins County Medical Society, at Ithaca, N. Y. Illustrated discussion of sanitary plumbing). Dom Enging—Dec., 1896. 2500 w. 30 cts.

10185. Advantages of Main-trap and Fresh-Air Inlet in House Drainage. J. J. Cullington (Discusses precautions necessary to have plumbing safe). San Plum—Jan. 1, 1897. 2000 w. 15 cts.

MISCELLANY.

9725. Progress in Sanitary Engineering. Andrew Noble (Address as President of the Section of Engineering and Architecture of the Congress of the Sanitary Institute, at Newcastle-on-Tyne. General discussion dealing with various branches). San—Dec., 1896. 5,000 w. 45 cts.

9732. Fireproofing as a Specialty. Joseph K. Freitag (Facts showing the drain on our national resources from fire losses and the expenses arising from them, and that proper fire protection must soon be recognized as a distinct branch of engineering). Purdue Soc of Civ Engs. 1896. 3,000 w. 45 cts.

9787. Electric Wiring. Thomas W. Flood (Read before the Boston Society of Architects. The necessity for architects to make provision in their plans for the electrical installation. Different classes of electrical work and their requisites). Am. Arch—Dec. 12, 1896. 2,000 w. 15 cts.

9823. Notes on the Building Exhibits at the Berlin Technical Exposition of 1896. (Der Hochbau auf der Berliner Gewerbe-Austellung, 1896.) Heinrich Koechlin (A brief notice of the exposition, followed by a review of the building trades exhibits, mainly of interior details. An account of the compressed air apparatus for removing the sewage from the exhibition is also given). Oesterr. Monat. O. B.—Dec., 1896. 12,000 w.

9824. Notes on the Graphical Computations of Frameworks. (Beitrage zur Graphischen Bercchnung des Fachwerks). L. Geusen (A combination of Ritter's method of sections and moments, with the modern polar graphostatic diagram). Z. Oesterr. I u A V—Nov. 20, 1896. Diagrams and 2,000 w.

9910. Terra-Cotta (Ill.). William F. Jelke (History of the industry and its successful application for architectural purposes). Yale Sci M—Dec., 1896. 1,900 w. 30 cts.

9947. Instruction in Architectural Drawing. William R. Ware (Revised copy from original in "School of Mines Quarterly." Part first deals with tracing and copying, giving many illustrations). Stone —Dec., 1896. Serial. First part. 2,400 w. 30 cts.

9969. Street Architecture. H. H. Statham (The architectural problem arising from the necessity of planting buildings as closely as possible together in cities is considered. A brief discussion follows). Arch, Lond—Dec. 11, 1896. 6,000 w. 30 cts.

9975. The Berlin Book of Buildings (A review of an illustrated and descriptive book of the architectural and constructional works of Berlin, issued in commemoration of the conference of the German architectural and engineering societies in the German capital). Builder—Dec. 12, 1896. 2,500 w. 30 cts.

9976. Color in the Architecture of Cities. Halsey Ricardo (Abstract of lecture given in connection with the Arts and Crafts Exhibition Society. Discusses the principle for the application of color, the value, with reference to color in Venice and other places). Builder—Dec. 12, 1896. 1,400 w. 30 cts.

9987. Fireproofing Buildings (Discusses means of making buildings already built of combustible materials, capable of resisting fire). Fire and Water—Dec. 19, 1896. 900 w. 15 cts.

10003. The Prevention of Rust in Iron and Steel Structures (Editorial showing the importance of this question and our duty to posterity). Sci Am—Dec. 26, 1896. 1,100 w. 15 cts.

10007. The Case Against the Ecole des Beaux-Arts. Ralph Adams Cram. (Read before the Boston Soc. of Arch'ts. Not an attack on the system of instruction, but an inquiry into the methods and results of this system of education, with a view to finding out if it is defective in certain directions). Am Arch—Dec. 26, 1896. 8,200 w. 15 cts.

10,044. The Ancient Town Halls of Europe. Dr. Rowand Anderson (Inaugural address to the Edinburgh Architectural Ass'n. Showing what was done by municipalities from the twelfth to the sixteenth centuries, in rearing buildings of beauty and magnificence, and encouraging art). Builder—Dec. 19, 1896. 3,500 w. 30 cts.

10,048. The Strength of Columns. J. B. W. Stokes (Brief abstract of paper read at meeting of the Glasgow and West of Scotland Technical College Scientific Soc., with list of tables giving information on this subject). Prac. Eng.—Dec. 18, 1896. 500 w. 30 cts.

10,133. A Plea for the Use of Natural Forms Revealed by the Microscope as Suggestions for Architectural Enrichment. W. H. Seth-Smith (Read before the Brit. Arch. Ass'n. Calls attention to the tendency of the human mind to weary of even beautiful forms, and points out the advantage of studying the beautiful forms revealed by the microscope, as suggestive to work in stone carving, &c. Discussion follows). Builder—Dec. 26, 1896. 5,000 w. 30 cts.

10,157. To Canterbury, Bath and Oxford. T. Raffles Davison (Architectural studies, with illustrations). Brit. Arch.—Dec. 18, 1896. 4,000 w. 30 cts.

10,166. The Temple Church. Alfred J. Glasspool (Historical and descriptive). Arch, Lond.—Dec. 25, 1896. 1,200 w. 30 cts.

10,179. Practical Masonry and Stone-Cutting. E. W. Hind (In this series of articles the artist proposes illustrating and explaining practical methods by which the stone-cutter may obtain the necessary moulds, &c., required to ascertain the correct shape and size of each piece which belongs to the more intricate problems. Part first deals with arches in circular walls; or, circle on circle simplified). Ill. Car. & Build—Dec. 25, 1896. Serial. 1st part. 1,100 w. 30 cts.

10,291. Test of the Bailey System of Fireproof Flooring (Description of construction and very successful test). Eng. News—Jan. 7, 1897. 350 w. 15 cts.

CIVIL ENGINEERING.

BRIDGES.

9695. The Mechanical Action and Resultant Effects of Motive Power at High Speeds on Bridges (Report presented to the Assn of Ry Supts of Bridges and Buildings). Can Eng—Dec. 900 w. 15 cts.

9699. Burlington Channel Swing Bridge (Illustrated description of a workable bridge under difficult conditions. The motive power is electricity). Can Eng—Dec. 1000 w. 15 cts.

9701. A Novel French Highway Bridge. From "Le Genie Civil." (General elevation and several details of a highway bridge of French design located in Paris. It carries an important street over the Orleans Ry). Eng News—Dec. 10. 450 w. 15 cts.

9821. The Distribution of the Pressure of Piers Upon Their Foundations. (Ueber die Vertheilung des Pfeilerdrückes in den Fundamenten.) Rudolf Mayer (A valuable contribution, with diagrams, to the important subject of the distribution of pressure in masonry piers). Z. Oesterr, I. u A. V.—Dec. 11, '96. 200 w.

9822. The Reconstruction of the Bridge Over the Inn Between Branau and Simbach. (Der Umbau der Branau-Simbacher Innsbrücke). Leopold Petri (Consists principally of a description of the construction of the masonry piers and their pneumatic foundations. Two plates of details of the caissons and air locks). Oesterr Monat O B—Dec., '96. 5,000 w.

9826. The Kornhaus Bridge at Berne. (Die Kornhausbrücke in Bern.) H. V. Linden (Four articles containing an account of the new iron arch bridge of 112.5 metres span to be built over the Aar. Detail drawings. Schw Bauz). Oct. 17 to Nov. 7, '96. 9000 w.

9913. Stone Filled Concrete Pier (Details of method for hastening the work of construction of the Cascade Bridge of Burlington, Iowa). Eng News—Dec. 17. 500 w. 15 cts.

9917. Double Deck Highway and Railway Bridge, Rock Island, Ill. (Illustrated description of one of the most important bridge structures constructed in the United States during the past year). Eng News—Dec. 17. 5000 w. 15 cts.

9952. Large Span Railway Bridges. E. W. Young (A letter discussing the proposed long span railway suspension bridge

across the Hudson River, and a short editorial reply). Engng—Dec. 11. 1500 w. 30 cts.

9973. Proposed Suspension Bridge of 200 Feet Span Over the Tegga River, near Demagiri, South Lushai Hills. H. C. Banerji (Description with drawings). Ind Engng—Nov. 14, 1896. 1200 w. 45 cts.

10103. The Mira River Bridge, Nova Scotia. M. Murphy (Brief account of bridge remarkable for the cheapness with which it was constructed). Eng News—Dec. 81, 1896. 400 w. 15 cts.

10176. The Rue de Tolbiac Bridge, Paris (A brief review of the novel and peculiar features, with interior perspective of one of the main spans). Eng Lond—Dec. 25, 1896. 900 w. 30 cts.

10285. The St. Lawrence Bridge Competition (Plans, with brief description, submitted by engineers from the United States, Canada, England and Belgium. Special features are given, with aggregate weights and cost). Eng News—Jan. 7, 1897. 4,200 w. 15 cts.

10287. The Terminals of the Brooklyn Bridge Railway (A review of past discussions regarding the facilities and an explanation of the changes made by the switching by electricity and their effect upon the solution of the difficulties). Eng News—Jan. 7, 1897. 2,200 w. 15 cts.

CANALS, RIVERS AND HARBORS.

9840. The Corner-Stone Laying of the New Harbor of Constanza (Die Grundsteinlegung im neuen Hafen von Constanza). Friedrich Bömches (Plan and description of the new docks and breakwater of which the corner-stone was laid last October, and which form part of the plan to facilitate the handling of the grain product of Western Europe to better advantage). Zeitschr. d. Oesterr. Ing. u. Arch. Vereines—Nov. 20, 1896. 2,500 w.

10027. Bombay Port Trust (A short description of the development of the property vested in the Trustees of the Port of Bombay. Gives the principal works and conveniences for shipping and traffic). Ind Engng—Nov. 21, 1896. Serial. 1st part, 900 w. 45 cts.

10100. Movable Dams on the Great Kanawha River, West Virginia (Photographs, general elevation and notes describing this work). Eng News—Dec. 31, 1896. 1,000 w. 15 cts.

10177. An Old West Country Canal (History of an old canal of England, the Grand Western Canal, constructed about a century ago). Eng, Lond—Dec. 25, 1896. 1,700 w. 30 cts.

10205. The Great Reservoir System of the Upper Mississippi. W. S. Harwood (Illustrated account of this unique enterprise, by which the water of the river is controlled in flood and drought, aiding navigation, commerce, and preventing deterioration of water used for domestic purposes and furnishing water for irrigation). Harper's Weekly—Jan. 9, 1897. 4,000 w. 15 cts.

10286. The History of the Monongahela Navigation Co. From the Pittsburg Times (The history from 1832 is reviewed, with information regarding further improvement). Eng. News—Jan. 7, 1897. 900 w. 15 cts.

HYDRAULICS.

10184. Familiar Methods for Calculating the Flow of Water Through Pipes (Abridged from an essay presented by the N. Y. delegation and read at the Master Plumbers' Annual Convention, Boston, June 27, 1888. Simple, practical rules for problems in hydraulics). San. Plumb—Jan. 1, 1897. 2,000 w. 15 cts.

IRRIGATION.

9733. The Irrigation Works of the Pecos Valley. Elwood Mead (An interesting description of the method used in this valley and the changes wrought by water). Purdue Soc of Civ Engs—1896. 1,800 w. 45 cts.

9915. The Ownership and Control of Water in the Irrigable West. Elwood Mead (Letter calling attention to features of the water laws not generally understood). Eng News—Dec. 17, 1896. 1,200 w. 15 cts.

10041. Water Development by Tunneling at Ontario, Cal. James T. Taylor (The object of this tunnel was to intercept the underflow from the mountain range known as the Sierra Madre and divert the water so developed by gravity into the present system for an increased supply of the Ontario lands. Account of work thus far). Eng News—Dec. 24, 1896. 800 w. 15 cts.

MISCELLANY.

9703. Proposed Standard Specifications for Portland Cement. William J. Donaldson (A reply to article by Mr. Lesley, which criticises the proposed specifications advanced by the writer). Eng News—Dec. 10. 5,000 w. 15 cts.

9719. Foundations. W. A. Truesdell (An embodiment of ideas and observations gathered during several years of practice). Wis Eng—Oct. 4,000 w. 45 cts.

9730. The Business Wisdom and Responsibility of the Engineer. W. F. Goodhue (A talk to young engineers on the subject named, from one whose experience and contact with men entitle him to consideration). Purdue Soc of Civ Eng—1896. 9,000 w. 45 cts.

9734. The Civil Engineer: His Work and Character. Rev. C. B. Wilcox (A talk to young engineers, showing the demand for their labor, and the qualities essential to success). Purdue Soc of Civ Eng—1896. 1,200 w. 45 cts.

9837. Concerning the Relation of Elasticity and Resistance of Pillars of Variable

Moduli of Elasticity.—Ueber die Elasticitäts und Festigkeits-Verhaltnisse von Stäben mit Verandlichen Elasticitätsmodul (A highly mathematical discussion of the subject of elasticity of compound structures, such as occur in the Melan system and elsewhere). Zeitschr d Oesterr Ing u Arch Ver—Dec. 25, 1896. 3,000 w.

9916. Standard Cement Specifications of the South Australian Government (A copy of the standard specifications for Portland cement supplied to Australia for use on its public works, under which satisfactory material has been for some time received). Eng News—Dec. 17. 1,100 w. 15 cts.

9941. Solar Work in Land Surveying. J. D. Varney (A statement of the principles involved and an exhibition of a new solar device. Illustrations). Jun Assn of Enging Soc—Nov. 5,400 w. 30 cts.

10039. The Late Gales and the Brighton Piers (Editorial comment on the injury caused by recent storms. The wrecking of Mr. Volk's electric tramway and the marine railway to Rottingdean, pleasure piers, &c.). Eng, Lond—Dec. 18, 1896. 1500 w. 30 cts.

10126. Highway Improvement in Vermont (Illustrated account of the work done by the State Highway Commission, with extract from second annual report). Munic Engng—Jan., 1897. 1800 w. 30 cts.

10284. The Manufacture of Slag Cement in France (Describes the manufacture as practiced in Vitry-le-Francois, one of the latest manufactories. From the "Nouvelles Annales da la Construction"). Eng News—Jan. 7, 1897. 700 w. 15 cts.

10288. A New Test of the Rate of Setting Cement. William S. Mac Harg (Letter presenting a simple method of testing the rate of setting of cement, apparently worthy of investigation. Also brief editorial). Eng News—Jan. 7, 1897. 1600 w. 15 cts.

ECONOMICS AND INDUSTRY.

COMMERCE AND TRADE.

9650.—The Paramount Control of the Commerce of the World. Edward Atkinson (Showing that the resources of the United States and the potential demand for them are sufficient to make her foremost in commerce whenever the questions of money, banking, and taxation shall be settled in accordance with economic law). Eng Mag—Jan. 7,800 w. 30 cts.

9651.—Evidences of Health Throughout the Industrial World. L. G. Powers (A statistical paper establishing a favorable contrast between the industry and commerce of 1896 and those of previous years). Eng Mag—Jan. 3800 w. 30 cts.

9728. The Commercial War Between Germany and England. B. H. Thwaite (The writer considers the secret of Germany's great industrial progress to be polytechnic education and philosophic training. He cites examples in proof of his opinions and recommends England to rely upon scientifically controlled industrial processes). Nineteenth Cent—Dec., 2,500 w. 45 cts.

9908.—The Cycle Industry in the United States. From the London Times (An interesting article showing the surprising development of this industry). Cons Repts—Dec. 2,000 w. 45 cts.

9919.—Future of American Manufacturers (Abstract of address by Mr. Theodore C. Search, Pres. of the National Assn. of Manufacturers. The magnitude of our industrial interests). Mfrs. Rec—Dec. 18. 2,400 w. 15 cts.

10000. The Department Store. Samuel Hopkins Adams (The first of a series of articles on "The Conduct of Great Businesses," showing the vital points of American business life. Dealing with the part men's brains play in large business enterprises. Illustrations). Scribner's Mag—Jan., 1897. 1,800 w. 30 cts.

10015. Details of Our Foreign Trade (The satisfactory condition of our export trade. Since 1895 our monthly exports have exceeded imports and the balance of trade been in our favor). Bradstreet's—Dec. 26, 1896. 1,000 w. 15 cts.

10018. Foreign Competition with British Trade (W. S. Harriss-Gastrell in his report to the Foreign Office. The necessity of effort to prevent any further loss of trade, with suggestions). Bd of Tr Jour—Dec., 1896. 2,500 w. 30 cts.

10019. Tariff Changes and Customs Regulations (Belgium, Germany, France, Italy, United States, Guatemala, Brazil, British India, Sierra Leone and Western Australia). Bd of Tr Jour—Dec., 1896. 1,800 w. 30 cts.

10098. Our Own Ships for Our Foreign Trade Essential to Prosperity. William W. Bates (Discusses the advantage of using shipping of our own and the disadvantage and loss of employing foreign shipping). Arena—Jan., 1897. 4,000 w. 80 cts.

10021. Business Failures in 1896 (Tabulated summary of the business embarrassments in the United States, Canada and Newfoundland for ten years, with assets and liabilities; also tabulated statement of mercantile failures for seven years, with remarks). Bradstreet's—Jan. 2, 1897. 800 w. 15 cts.

10231. Foreign Trade of the United States. Worthington C. Ford (Calling attention to some notable characteristics that are concealed from view during sea-

sons of prosperity). Tradesman—Jan. 1, 1897. 3,300 w. 15 cts.

10232. Future Trade with South America. C. D. Mitchell (The practical work undertaken by the National Association of Manufacturers). Tradesman—Jan. 1, 1897. 1,700 w. 15 cts.

10233. Important Features in Southern Export Trade Which Manufacturers Cannot Overlook. Henry S. Fleming (Calls attention to the introduction of goods, the class of goods required, measurements, packing and credits). Tradesman—Jan. 1, 1897. 1,200 w. 15 cts.

10234. Export Trade in the South. Charles Earl Currie (In regard to the selection of foreign territory in which to introduce Southern goods, transportation facilities, &c). Tradesman—Jan. 1, 1897. 4,000 w. 15 cts.

10235. Our South American Trade. Edwin Lefevre (The necessity for better acquaintance with the requirements of the sister republics). Tradesman—Jan. 1, 1897. 4,000 w. 15 cts.

10243. How to Promote Industrial Growth (A series of opinions by officers of the largest commercial organizations in the South). Tradesman—Jan. 1, 1897. 1,800 w. 15 cts.

10270. An English View of German Trade Rivalry (The effect of the enforced label "Made in Germany" is shown to have been a benefit. The statements made in book by Ernest Edwin Williams are cited and various industries discussed). Cons Repts—Dec., 1896. 2,000 w. 45 cts.

CURRENCY AND FINANCE.

9652. Public Credit as Related to Engineering Enterprise. Gustav Lindenthal (Reviewing the great engineering projects that are awaiting for their realization only a renewal of confidence and a consequent availability of capital). Eng Mag—Jan. 4,200 w. 30 cts.

9682. The Monetary Issue in the United States (Explains the main issue in the late Presidential campaign as presented by Mr. Horace White). Bankers' Mag, Lond—Dec. 1,500 w. 30 cts.

9727. Money and Investments. Emma Cons (The article is devoted largely to the question at stake in the last Presidential campaign in the U. S., and to criticism of management of finances in the U. S. Other issues of special interest to England are briefly considered). Contemporary Rev—Dec. 5,500 w. 45 cts.

10014. Carlisle on Currency and Revenue Legislation (His argument in the last annual report as to the need of legislation to retire the greenbacks). Bradstreet's—Dec. 26, 1897. 1,800 w. 15 cts.

10152. Financial Review of the Year (The financial events for the year 1896 are briefly traced). Eng & Min Jour—Jan. 2, 1897. 900 w. 15 cts.

10206. Some Practical Suggestions from Students of Finance (A symposium of opinions of representative economists identified with leading American universities). Rev of Revs—Jan., 1897. 10,500 w. 30 cts.

GOVERNMENTAL CONTROL.

9788. The Working of Arbitration. H. W. Wilson (A collection of instances which the writer claims give a fair idea of the working of arbitration. The dangers and defects are shown). Fortnightly Rev—Dec. 5,000 w. 45 cts.

9918. The Nicaragua Canal. Joseph Nimmo, Jr (An appeal for a thorough governmental investigation of its commercial and military aspects). Mfrs Rec—Dec. 18. 2,800 w. 15 cts.

LABOR.

9833. The Industrial Colony of the Salgo-Tarjan Coal Mining Company (Die Arbeiter-Colonien der Salgo-Tarjaner Kohlenbergbau - Actien - Gesellschaft). Alois Meissner (An interesting account of the co-operative association at Salgo-Tarjan, with plans of the property and houses). Plate. Oesterr. Monatschr. f. d. Oeff. Bau—Dec., 1896. 2,000 w.

9909. Rates of Wages Paid Under Public and Private Contract. Ethelbert Stewart (Tables giving the results of investigations in the cities of Baltimore, Boston, New York and Philadelphia as to wages paid for the same occupations and similar work). Bul of Dept of Labor—Nov. 5,000 w. 45 cts.

9958. A Curious Strike (Editoral on the strike at the works of Messrs. Gwynne & Co., Brook-street, Holborn). Eng Lond—Dec. 11. 1,100 w. 30 cts.

10097. Strikes as a Factor in Progress. M. E. J. Kelley (Showing how from the workman's point of view all strikes are beneficial to the working people, whether they succeed or not). N Am Rev—Jan., 1897. 2,800 w. 45 cts.

10099. The Plea of Labor from the Standpoint of a Russian Peasant. Ernest Howard Crosby (Abstract of and comment on a book entitled "Work, According to the Bible," by Timothy Michaelovitch Bondareff). Arena—Jan., 1897. 4,800 w. 30 cts.

10106. A Threatened Strike on the London & North Western Railway. W. M. Acworth (An account of an escape from what looked like a serious crisis on this railway). R R Gaz—Jan. 1, 1897. 2,000 w. 15 cts.

10138. Strike at the Plymouth Gas Works (An account of the trouble and its settlement). Jour of Gas Lgt—Dec. 22, 1896. 2,000 w. 30 cts.

10165. Employers' Liability and Compensation to Workmen (Suggestions offered by a correspondent of the London Times in regard to the present law of England on this subject). Arch Lond—Dec. 25, 1896. 1,200 w. 30 cts.

10214. An American System of Labor Pensions and Insurance. Paul Monroe (The various methods for industrial amelioration are discussed, and the needs as met in different countries and as required by different nationalities. The system in operation in the extensive manufacturing enterprises of Alfred Dolge & Son at Dolgeville, N. Y., is given). Am Jour of Soc—Jan., 1897. 5,000 w. 45 cts.

10215. Eccentric Official Statistics. H. L. Bliss (A criticism of statistics furnished by the government, especially in regard to labor and trade). Am Jour of Soc—Jan., 1897. 5,400 w. 45 cts.

10225. Labor Organizations Made a Necessity by Actions of Managers of Industrial Establishments. B. R. Lacy (Claiming that the treatment of workmen causes labor organizations, and that sufficient work cannot be provided until idle money is invested). Tradesman—Jan. 1, 1897. 1,400 w. 15 cts.

10271. Evolution of English Trade-Unionism (Extracts from a paper on "Primitive Democracy in British Trade-Unionism," by Sidney and Beatrice Webb, of London, published in the Political Science Quarterly). Gunton's Mag—Jan., 1897. 2,200 w. 30 cts.

MISCELLANY.

9663. Abuses of Our Patent System by Trusts, Corporations, Lawyers and Experts (The first of a series of articles aiming to show how the powers of "Trusts" are used for the purpose of strangling legitimate and worthy enterprises, and to illustrate the manner in which the patent laws are made to serve infamous purposes). Elec—Dec. 9. Serial, 1st part. 1,300 w. 15 cts.

9726. The Unemployed. W. R. Bousfield (Comment and criticism on the reports of select committees on distress from want of employment. The question of the unemployed is discussed by the critic from a classification made by him). Contemporary Rev—Dec. 8,000 w. 45 cts.

10216. The Present Status of Sociology in Germany. Dr. O. Thon (Part first shows reasons which partly account for its rejection as a science and explains the form it has assumed in Germany. A study of the subject is commenced). Am Jour of Soc—Jan., 1897. Serial, 1st part. 8,000 w. 45 cts.

10217. Principles of Public Charity and of Private Philanthropy in Germany. Dr. E. Muensterberg (A report on the system of poor relief in use in Hamburg). Am Jour of Soc—Jan., 1897. Serial, 1st part. 5,000 w. 45 cts.

10272. Failure of the Nail Combine (History of the combination). Gunton's Mag—Jan., 1897. 2,200 w. 30 cts.

10273. Natural Causes of Agricultural Depression. Jerome Dowd (Showing why agriculture in many localities is unprofitable. That the outlook is not necessarily gloomy). Gunton's Mag—Jan., 1897. 1,200 w. 30 cts.

10292. Values, Positive and Relative. W. G. Langworthy Taylor (A scientific study. The conception of value pointed out is the result of a desire to contribute to a solution of the question of deferred payments). An Am Acad—Jan., 1897. 10,800 w. $1.

10295. Official Statistics of India-Rubber and Gutta-Percha (Statistics for the export and import trade of the year ending June 30, 1896). Ind Rub Wld—Jan. 10, 1897. Tables. 35 cts.

ELECTRICAL ENGINEERING.

ELECTRO-CHEMISTRY AND METALLURGY.

9688. Electrolytic Precipitation of Gold from Cyanide Solutions. Stuart Croasdale (Experiments were made and reasons given for the method decided upon, which was electrolytic precipitation, using amalgamated zinc plates for the positive electrodes and sheet lead for the negative electrodes). Eng & Min Jour—Dec. 12, 1896. 750 w. 15 cts.

9805. The Application of Porous Carbon Cells in Electrolysis. (Die Verwendung Poröser Kohlecylinder bei Elektrolytischer Versuchen). Walther Lob. (Porous Cells of Carbon were used with solutions to be decomposed placed within and without. The carbon was used either as cathode or merely as a separating conductor. In the former case the decomposition takes place both within and without the carbon cell). Zeitschrift für Elektrochemie—Nov. 5, 1896. 2000 w.

9806. The Generation of Electricity by Chemical Action. (Elektricitätserregung auf Chemischem Wege). Ernst Andreas (A description of an improved gas battery in which the elements are composed of net-works of platinum wire between sheets of blotting paper, excited by various gases. It is suggested that this may be made available for the generation of electricity as a by-product in some chemical industries, such for example as the manufacture of sulphuric acid). Zeitschrift für Elektrochemie—Nov. 5, 1896. 1200 w.

9807. Electric Furnaces for the Separation and Refining of Metals. (Die Elektrischen öfen zur Metallgewinnung und Metallraffination). Dr. W. Borchers (The

first of a series of articles upon electric furnaces. This installment contains a classification and a brief description of some of the earlier types). Zeitschrift für Elektrochemie—Nov. 5, 1896. Ill. 2000 w.

9809. The Meaning of Arrhenius' Theory of Ion Groups in Analytical Chemistry. (Die Bedeutung der Arrhenius' schen Theorie der Ionenspaltung fur die Analytische Chemie). F. W. Kuster (Showing the application of Arrhenius' theory to analysis by passing an electric current through the solution and observing the conductivity and polarity). Zeitscrift für Elektrochemie—Dec. 5, 1896. 2500 w.

9810. Concerning the Influence of Intermediate Conductors. (Ueber das Verhalten von Mittelleitern). Dr. Hugo Kauffman (A mathematical investigation of the action of isolated conductor placed in a solution undergoing electrolysis. This bears upon the same subject as No. 9805, in which a porous carbon cell plays such a part). Zeitschrift für Elektrochemie—Dec. 5, 1896. 1500 w.

9811. The Use of Electrically Produced Chloride of Lime in Cotton and Linen Bleaching. (Praktische Ergebnisse bei Anwendung van auf Elektrolytischem Wege Hergestellten Chlorkalk in der Baumwoll und Leinenbleicherei). (This article shows that chloride of lime produced by the electrical decomposition of common salt possesses especial advantages for bleaching purposes, both for superior results and greater economy, and pronounces its introduction as a great step forward.) Elektrochemische Zeitschrift—Nov., 1896. 1500 w.

9812. Concerning Accumulators with Gas Relief. (Ueber die Akkumulatoren mit Entgasungseinrichtung). Jos. Zacharias (This is a description of improvements in electrical accumulators in which opportunity is given for the free escape of the gases which otherwise cause the rapid deterioration of the elements. The use of organic materials for the absorption of the gases is also suggested). Elektrochemische Zeitschrift—Nov., 1896. 3000 w.

9813. A new Method of Separating Metals by Means of Soluble Anodes. (Eine Neue Trennung von Metallen Mittels Löslicher). R. Pauli. (An extension to other metals of the principle exhibited by the deposition of copper upon iron from a solution of cupric sulphate, or of iron upon zinc.) Elektrochemische Zeitschrift—Nov., 1896. 1,000 w.

9843. Progress in the Electro-Chemical Industry. (Fortch schritte auf dem Gebiete der Elektrochemischen Industrie). Dr. Hugo Ritter v. Perger. (An address delivered before the Society of Austrian Engineers and Architects, reviewing the applications of electricity to industrial chemistry during the last few years. Two articles. Zeitschr. d. Oesterr. Ing. u. Arch. Vereines—Dec. 11 and 18, 1896. 12,000 w.

9981. On the Manufacture of Alkali and Bleach by Chemical and Electrolytical Methods. Bertram Blount (Read before the Northern Soc. of Elec. Engs. A comparison and a summing up of the weak and strong points of the two methods). Elect'n—Dec. 11, 1896. 5,500 w. 30 cts.

10178. Electricity in Relation to the Chemical and Metallurgical Industries. John B. C. Kershaw (This series of articles' proposes to notice the electro-chemical and electro-metallurgical processes now at work on an industrial scale, so far as information concerning them is obtainable, thus providing a general review of these industries at the end of 1896). Elect'n—Dec. 25, 1896. Serial, 1st part. 1,000 w. 30 cts.

10208. On the Formation of Lead Sulphate in Alternating Current Electrolysis, with Lead Electrodes. Samuel Sheldon and Marcus B. Waterman (Results of experiments to determine whether electrolytic condensers, formed with lead electrodes, might not have a high efficiency, acting much in the same manner as the lead plates of a storage battery). Phys Rev—Jan.-Feb., 1897. 1,200 w. 50 cts.

10211. On the Hydrolysis of Ferric Chloride. H. M. Goodwin (Results of some experiments on the changes which take place in a neutral ferric chloride solution when suddenly diluted. Based on the electric conductivity). Tech Quar—Dec., 1896. 3,600 w. 75 cts.

LIGHTING.

9677. Two Interesting Small Electric Lighting Plants. C. G. Robbins (Describes two plants containing many features of interest. The plant of F. & R. Lazarus, at Columbus, O., and the plant known as No. 1 plant of the Block Lighting and Power Co., located in New York City. Illustrated). Power—Dec. 3,800 w. 15 cts.

9714. Portable Electric Plant for Show Lighting (Describes the electrical equipment and illustrates the plant used by "Buffalo Bill's Wild West"). W Elec—Dec. 12. 1,000 w. 15 cts.

9769. The Electric Arc for Lantern Projection. E. P. Hopkins (The main difficulties with other forms of illumination are briefly presented, and the article describes in detail the arc light as applied to this use, pronouncing it the most perfect and ideal illuminant for the work). Elec Eng—Dec. 16. Serial. 1st part. 1,200 w. 15 cts.

9846. The Lighting of Theatres by the Fredereau Diffusers (L'Eclairage des Theatres et les Globes Diffuseurs Fredereau). G. Mercier (An illustrated de-

scription of the installations of the Fredereau Diffusers at the Casino de Cabourg and at the Monte Carlo Theatre). La Révue Technique—Nov. 10, 1896. 1,000 w.

9934. Principles of Electrical Distribution. Francis B. Crocker (The subject is studied in connection with electric lighting, although it applies to all branches of electrical transmission and distribution. Part first discusses materials for electrical conductors, electrical resistance and the standard conductivity of copper). Elec Wld—Dec. 19. Serial. 1st Part. 2,000 w. 15 cts.

9940. Armorite Interior Conduit (Illustrated description of a new electrical specialty). W Elec—Dec. 19. 2,000 w. 15 cts.

9997. How to Make a Constant Potential Arc Lamp. Cecil P. Poole (Sketches and instructions that will enable any mechanic to make a reliable arc lamp, if he has a fair knowledge of electrical apparatus). Am Elect'n—Dec., 1896. 1,700 w. 15 cts.

10006. Hand Feed Electric Lamp for Lanterns. George M. Hopkins (Illustrated description). Sci Am—Dec. 26, 1896. 800 w. 15 cts.

10034. Chester Electricity Works. (Illustrated detailed description). Elec Eng, Lond—Dec. 18, 1896. 5500 w. 30 cts.

10081. Electric Lighting of the Royal Poinciana Hotel at Palm Beach, Florida (Illustrated description). Elec Eng—Dec. 30, 1896. 800 w. 15 cts.

10118. Good and Bad Steam Piping for Electric Lighting Engines in Office Buildings (Deals with the steam piping of an office building where the head room is restricted and the practice of large central stations is impossible. Discusses methods and dangers). Eng Rec—Jan. 2, 1897. 1600 w. 15 cts.

10163. Malta Electricity Supply (A detailed description of the works which have been undertaken by the Government of Malta). Elec Eng, Lond—Dec. 25, 1896. 2500 w. 30 cts.

10172. Electrical Work in South America (Brief account of progress, especially in Buenos Ayres). Elec Rec Lond—Dec. 25, 1896. 900 w. 30 cts.

10187. Oriental Electric Lighting. Lester Betts (Part first deals with the selection of the most suitable estimate and specification submitted. The series seems to aim to give information that will insure the selection of good material and the installation of a successful plant). Ind and East Eng—Dec. 5, 1896. Serial first part 1500 w. 45 cts.

10249. The City Council Electric Light Plant in Melbourne, Australia. Frank W. N. King (Illustrated description of the works of the Melbourne City Council). Elec Wld—Jan. 2, 1897. 1600 w. 15 cts.

10274. Decorative Lighting. E. J. Jenness (Read before the Chicago Elec Assn Dec. 16, 1896. Considers lighting effects as applied to scenic theatres and decorative work as applied to tower lighting for advertising and other purposes). W Elec —Jan. 9, 1897. 2,300 w. 15 cts.

POWER.

9655. The Wonderful Expansion in the Use of Electric Power. Ill. Louis Bell (Tracing the development of electrical applications to the problems of transportation and transmission). Eng Mag—Jan. 3,700 w. 30 cts.

9690. External Regulation of Alternating-Current Motors. Albert G. Davis (Describes devices for the speed regulation of alternating-current motors in which the speed of the motor is controlled by changing the character of the current delivered). Elec Wld—Dec. 12. 1,700 w. 15 cts.

9691. Shunt Motors for Railway Work. William Baxter, Jr. (The objections and advantages are given and the subject discussed, showing that shunt-wound motors arranged so that the fields may be commuted have many desirable features and may possibly be made as reliable as series motors). Elec Wld—Dec. 12. 2,500 w. 15 cts.

9721. Comparative Commercial Qualities of Alternating Current Motors. W. H. Williams and J. H. Perkins (Synopsis of thesis submitted for the degree of Bachelor of Science in Electrical Engineering. Describes a series of tests of 5 H. P. alternating current motors of various makes. A table of comparative qualities and efficiency curves of several of the latest type direct current motors are given). Wis Eng —Oct. 1,300 w. 45 cts.

9723. Electric Motors in Factories. C. M. Conradson (The writer is a believer in direct connected motors wherever possible. Tests were made by the writer and conclusions are given). Wis Eng—Oct. 2,700 w. 45 cts.

9770. A New Method of Speed Control for Electric Motors. W. A. Anthony (Views of the writer on this subject. Describes a method which he believes will be found valuable in most cases where variable speed is required). Elec Eng—Dec. 16. 800 w. 15 cts.

9791. Some Problems in Electric Elevator Work. H. Cochrane (The writer reviews some of the details of practical construction, showing that the application of electricity to elevator service involves a great many engineering problems. Illustrated). Sib Jour of Engng—Dec. 5,000 w. 30 cts.

9800. Motor and Magnetic Brakes for Trolleys. (Motorische und Magnetische Bahnbremsen). Max Schieman (An examination of the use of reverse current braking and of the use of electro-mag-

netic brakes acting upon friction disks attached to the axles. 5 illustrations). Deutsche Zietschrift für Elektrotechnik—Oct. 15, 1896. 2,500 w.

9801. Electrical Plants for Small Towns. (Elektricitätswerke für Kleine Städte) (A warning to small towns against the hasty adoption of electric lighting, and a review of the conditions under which such installations are likely to be successful). Deutsche Zeitscrift für Elektrotechnik—Oct. 15, 1896. 700 w.

9906. Electrical Devices for Changing the Speed of Shunt Motors. William Baxter, Jr (Discusses the methods for changing the speed of shunt motors). Am Mach—Dec. 17. 1,400 w. 15 cts.

9939. Smith's Electro-Magnetic Elevator (Illustrated description of an elevator possessing features of interest. It makes use of the principle of the solenoid or coil and plunger to utilize the power to move the car). W Elec—Dec. 19. 3,700 w. 15 cts.

9980. A 640 Horse-Power Hutin-Leblanc Alternater with Stationary Armature. F. Guilbert (Abstract of an article in L'Industrie Electrique of Nov. 10. Illustrated description). Elect'n—Dec. 11, 1896. 1300 w. 30 cts.

9988. The Bridge Mill Power Plant of the Pawtucket, R. I. Electric Co. (Illustrated description). Elec Eng—Dec. 23, 1896. 3000 w. 15 cts.

9990. The Churchward Equalizer System of Distribution. A. Churchward (Describes a system which has been in use in a central station in New York City for three years without a breakdown in the balance of the two circuits. Illustrated). Elec Eng—Dec. 23, 1896. 800 w. 15 cts.

10017. The Relation of Magnetic Flux to Output in Dynamos. P. M. Heldt (An attempt is made to deduce an algebraic relation between the useful magnetic flux and the output of a dynamo, and to evaluate the constant occurring in this equation from the data of actual machines). Elec Wld—Dec. 26, 1896. 1,100 w. 15 cts.

10093. The Latest Improvements in Electric Elevators (Illustrated description of high grade electric passenger-elevator used in fireproof buildings). Sci Am—Jan. 2, 1897. 1,100 w. 15 cts.

10222. What Has Been Accomplished in the Long-Distance Transmission of Power by Electricity (A summary of what has been accomplished in this line, with illustrations of the different plants, giving an idea of their character and magnitude). Am Mach—Jan. 7, 1897. 2,000 w. 15 cts.

10248. Fuel Energy Into Electrical Energy. Elihu Thomson (Reviews the various types of apparatus for effecting the conversion, and concludes that there is not for the present any danger of boilers and engines passing out of use). Elec Wld—Jan 2, 1897. 1,500 w. 15 cts.

10250. Parallel Operation of Alternators. Charles Proteus Steinmetz (Advises the operation in parallel wherever feasible and showing that if equality of frequency and constancy of frequency have been provided for, they will run satisfactorily, and if they cannot be fulfilled, parallel operation is impracticable). Elec Wld—Jan. 2, 1897. 1,400 w. 15 cts.

10254. The High-Tension Accumulator of the Jefferson Physical Laboratory of Harvard University. John Trowbridge (Constructed for the study of the discharges of electricity through gases. Description and account of satisfactory work). Elec Wld—Jan. 2, 1897. 1,300 w. 15 cts.

10257. Alternating Current Machinery. Edwin G. Houston and A. E. Kennelly (It is proposed in this series of articles to discuss the development, laws and properties of alternating currents and the methods of their practical application to the transmission of power. Part first is introductory). Elec Wld—Jan. 2, 1897. 1,000 w. 15 cts.

TELEGRAPHY AND TELEPHONY.

9704. The Basis of Telephone Charges. Fred De Land (A table is given showing the possible combinations as based on the number of subscribers, and how expenses increase). Elec Engng—Dec. 900 w. 15 cts.

9706. European Telephone Statistics for the Year 1894. Franz J. Dommerque (Table calculated from data furnished by the "Journal Telegraphique"). Elec Engng—Dec. 350 w. 15 cts.

9715. Proposed Consolidation of the Commercial Cable and Postal Telegraph-Cable Companies (An outline of the history of the two companies, and statement of the conditions on which a consolidation is proposed) W Elec—Dec. 12. 1,000 w. 15 cts.

9771. The New Cable to Hayti (Map showing course of the new cable, with connections. Also brief account of rates and matters of interest). Elec Eng—Dec. 16. 600 w. 15 cts.

9907. Through Telephone Eyes (Views on European methods as given by general manager Angus S. Hibbard, of the Chicago Telephone Co.) Elec Rev—Dec. 16. 1,300 w. 15 cts.

9970. Postal Telegraphs—New Form of Morning Test Switch Tablet (Illustrated description of arrangement). Elec, Lond—Dec. 4, 1,100 w. 30 cts.

10011. The Making and Laying of an Atlantic Cable. Henry Muir (Illustrated description of the work of constructing, laying and repairing cables). McClure's Mag—Jan., 1896. 5,000 w. 15 cts.

10032. Localizing Faults in Submarine Cables. Herbert E. Cann (Tables showing different strengths of currents, com-

parison of results, testing through an artificial cable, and through wire resistance, are given and explained, and conclusions from a series of experiments are given). Elec Rev, Lond—Dec. 18, 1896. 1,800 w. 30 cts.

10082. Military Telegraph Line from Bisbee to San Bernardino, Arizona. W. A. Glassford (An account of the erection of this line, the difficulties met and the purpose which these lines serve). Elec Eng—Dec. 30, 1896. 2,000 w. 15 cts.

10085. Telephoning and Telegraphing with a Kite Wire. William A. Eddy (An account of an interesting and successful experiment). Elec Rev—Dec. 30, 1896. 550 w. 15 cts.

10111. The Edison Phonoplex (Illustrated description with diagram of the connections for a terminal office). R R Gaz—Jan. 1, 1897. 1,200 w. 15 cts.

10247. Submarine Telegraphy. From La Nature (The new cable from Brest to New York. Also some of the difficulties in transatlantic telegraphing Sci Am Sup—Jan. 9, 1897. 1,400 w. 15 cts.

10255. Progress in American Telegraphy. F. W. Jones (Historical review). Elec Wld—Jan. 2, 1897. 2,500 w. 15 cts.

10256. The interests of the Public in the Telephone Situation. F. W. Dunbar (History of the telephone development and of the contract that divided the interests of telephony and telegraphy is given in part first, with statement of the requirements of the combined system). Elec Wld—Jan. 2, 1897. 2,300 w. 15 cts.

10269. Auxiliary Telegraphy. Dr. I. Kitsee (Illustrates and describes a device for overcoming the difficulty in transmitting messages from and to intervening stations while the line is in use at the terminal offices). Jour Fr Inst—Jan., 1897. 1,800 w. 45 cts.

10275. The Persian Gulf Cable of 1864. F. C. Webb (A sketch of the laying of the Persian Gulf Cable of 1864). W Elec—Jan. 9, 1897. Serial. First part. 1,900 w. 15 cts.

10294. Machinery for Cable Making (Illustrated description of sheathing machine, with reference to other machines used in the manufacture of submarine cables). Ind Rub Wld—Jan. 10, 1897. 700 w. 35 cts.

MISCELLANY.

9673. Electrical Speed Indicator (Describes and illustrates a revolution indicator, based upon an entirely new principle. One of the effects of the apparatus in marine work is to enable the two engines of a twin-screw ship to be kept at the same speed). Am Mach—Dec. 10. 600 w. 15 cts.

9678. A Few Points on the Care of Electrical Machinery. William Baxter, Jr. (Deals especially with the adjustment and care of brushes). Power—Dec. 4,800 w. 15 cts.

9705. The Manufacture of Wire. Frederic A. C. Perrine (The general types of insulators are described which are regularly employed for protecting wires, and the protection where necessary to prevent injurious mechanical and chemical action). Elec Engng—Dec. 7,500 w. 15 cts.

9781. The Measurement of Temperature: An Application of the Measurement of Resistance. G. M. Clark (The writer proposes to give an outline of the elements of the subject of thermometry, dealing rather with principles than details. Subsequently he will deal with the measurement of resistance, treating the subject in detail). Elec'n—Dec. 4. Serial. First part. 3,000 w. 30 cts.

9782. A Residual Photo-Electric Effect of Cathode Rays. J. Elster and H. Geitel, in Weid Ann (Describes in detail experiments and results). Elect'n—Dec. 4, 1896. 2,800 w. 30 cts.

9802. Wilhelm Hittorf (A biographical notice of Dr. Hittorf and a review of his career, upon the fiftieth anniversary of his reception of his doctor's degree. Portrait). Zeitscrift für Elektrochemie—Oct. 20, 1896. 1,000 w.

9803. A New Method for Determining Capacity for polarization. (Eine Neue Method für die Bestimmung der Polarisations Kapazität). C. M. Gordon (A paper before the Institut für Elektrochemie of Gottingen, describing a method for determining polarizing capacity by means of an induction coil and a varying liquid resistance, in connection with a Wheatstone bridge). Zeitschrift für Elektrochemie—Oct. 20, 1896. 1,200 w.

9804. Thermic Electrolytic Chains. (Ueber Elektrolytsche Thermoketten). William Duane (A contribution to the transactions of the Royal Prussian Academy of Sciences of Berlin. This is an investigation into the production of electrolytic action by a series of solutions of different temperatures). Zeitschrift für Elektrochemie—Oct. 20, 1896. 1,200 w.

9814. A Fragmentary Discussion of the So-called Electric Current. (Ein Diskontinuierliches Bild des Sogen. Elektrischen Leitungsstroms). Dr. Ludwig Silberstein (A mathematical discussion of some of the features of Maxwell's and Hertz's theories). Elektrochemisches Zeitschrift—Dec., 1896. 4,500 w.

9815. The Gulcher Accumulator. Die Gülcher - Akkumulatoren (Gulcher's improved storage battery plate is composed of a grating of leaden wires used as a warp, with a woof of fine strands of spun glass, the whole being charged with a paste of white lead). Elektrochemische Zeitschrift—Dec., 1896. Illustrated. 500 w.

9816. Novelties in Electrodes. (Neuer-

ungen an Elektroden). Dr. H. Weyer (Two articles containing a general review of improvements in all kinds of electrodes, with references to German and English patents). Elektrochemische Zeitschrift—Nov. and Dec., 1896. Both articles 5,000 w.

9817. Concerning Lightning Rods. (Zur Blitzableiterfrage). Prof. A. Weiler (A suggestion that effective protection against lightning may be obtained by four metallic conductors running from a common point on the roof to the ground down the four corners. This is based on the fact that an electroscope surrounded by four such wires shows no indication even of strong sparks). Elektrotechnische Rundschau—Nov. 1, '96. 200 w.

9818. The Therapeutic Effect of Electrical Currents of High Frequency. (Die Therapeutischen Wirkungen Elekthischer Ströme von Honer Wechselzahl) (An account of a repetition by Dr. Krebs of d'Arsonval's experiments. Beneficial results were obtained in cases of diabetes). Elektrotechnische Rundschau—Dec. 1, '96. 3500 w.

9819. The Cupric Oxide Element. (Das Kupferoxydelement). P. Geibel (An account of the so-called "Cupron-Element" battery and of the use of cupric oxide in accumulator cells). Elektrotechnische Rundschau—Dec. 1, '96. 2000 w.

9933. Physiological Effects of the Rontgen Tube. W. M. Stine (The writer thinks they are the result of stimulation and gives reasons for the opinion). Elec Wld —Dec. 19. 900 w. 15 cts.

9972. Installation Testing. V. Zingler (The object of these notes is to provide a methodical way of testing for and tracing out faults, earths, or short circuits; also to give probable causes of same, and to suggest precautions to be taken to guard against their occurrence). Elec Rev, Lond —Dec. 11, 1896. Serial. First Part. 1,600 w. 30 cts.

9982. Dr. Jacques's Cell (Editorial criticism of article entitled "Electricity Direct from Coal," by Dr. William W. Jacques, published in Harper's Magazine for Dec., 1896). Elect'n—Dec. 11, 1896. 1,100 w. 30 cts.

9983. On the Magnetic Permeability of Liquid Oxygen and Liquid Air. J. A. Fleming and James Dewar (Read before the Royal Soc. Describes investigations). Elect'n—Dec. 11, 1896. 3,500 w. 30 cts.

9989. Are Central Stations Doomed? "Engineer" (The writer does not think central stations are doomed, but thinks the prevailing methods of stock manipulation are). Elec Eng—Dec. 23, 1896. 800 w. 15 cts.

9992. Electricity at the College of Physicians and Surgeons (Illustrated detailed description of the extensive applications of electricity in this branch of Columbia University). Am Elect'n—Dec., 1896. 1,000 w. 15 cts.

9995. Magnetic Hysteresis. Ernest J. Berg (Explains the term and discusses the causes and effects). Am Elect'n—Dec., 1896. 1,200 w. 15 cts.

9996. A Method for Measuring Resistance. H. Beinhorn (Describes a method depending upon the value of the current becoming a maximum or minimum when the resistance is changed according to a certain law). Am Elect'n—Dec., 1896. 900 w. 15 cts.

10016. Electricity in the Weather Bureau (Illustrated description of interesting features of the electrical instruments in use in the U. S. Weather Bureau in the Manhattan Life Building in New York). Elec Wld—Dec. 26, 1896. 1,800 w. 15 cts.

10145. The Theory of the Wiring Table. Thomas G. Grier (Explains method of getting at once the result in the commercial size of wire from use of table). W Elec—Jan. 2, 1897. 1,600 w. 15 cts.

10171. Communication Between Coast and Lightships (Editorial comment on the failure in the attempts to establish electrical communication). Elec Rev, Lond—Dec. 25, 1896. 2,500 w. 30 cts.

10173. The Validity of the Use of Sine Curves in Alternating Current Problems. W. G. Rhodes (Justification of the use of sine functions in the calculation of alternating current problems). Elec Rev. Lond —Dec. 25, 1896. 1,100 w. 30 cts.

10209. Polarization and Internal Resistance of a Galvanic Cell. B. E. Moore and H. V. Carpenter (Experiment, made with the object to measure the electromotive force and its changes upon closed and open circuit between the zinc and main carbons, to get the electromotive force between the zinc and special carbon at intervals, and also to obtain the electromotive force of the carbon series during the progress of the experiment, with tabulated results.) Phys Rev—Jan.-Feb., 1897. 2,000 w. 50 cts.

10210. An Apparatus for Illustrating Phase-Differences. Louis Derr (Describes an apparatus devised by the writer for showing phase-relations on a scale suited to lecture-room illustration, its operation depending on the principle that when an electric current is sent through a wire lying perpendicularly across a magnetic field, a force is developed which urges the wire at right angles to both the direction of the field and the current. Illustration). Tech Quar—Dec., 1896. 800 w. 75 cts.

10239. Southern Electrical Progress as Evidenced by the Work Performed During the Past Year. F. W. Willcox (Review of all branches of electrical work for 1896). Tradesman—Jan. 1, 1897. 4,500 w. 15 cts.

10251. On the Prospective Development of Ether Theories. Reginald A. Fessenden (Mathematical development of theories, with discussion of defects). Elec Wld—Jan 2, 1897. 1700 w. 15 cts.

10252. The Heating of Magnet Coils. Henry S. Carhart (Investigations and formula). Elec Wld—Jan. 2, 1897. 1000 w. 15 cts.

10253. Theories of the Jacques Cell. C. J. Reed (An instructive study of the possibilities of the cell). Elec Wld—Jan. 2, 1897. 3300 w. 15 cts.

10268. Observations on Magnetized Watches. William T. Lewis (Gives illustrated description of a demagnetizer being constructed by the writer; also explains the usual method of detecting magnetism in a watch and of overcoming it). Jour Fr Inst—Jan., 1897. 1500 w. 45 cts.

10276. Electrical Progress in 1896. Charles G. Armstrong, in the Chicago Record (Review of progress in electrical interests, showing substantial improvements and healthy growth). W Elec—Jan. 9, 1897. 2300 w. 15 cts.

10277. Future Electrical Development (An interview with Prof. Amos E. Dolbear, in which he mentions a few of the things which he considers may transform business methods and habits of society). W Elec—Jan. 9, 1897. 2,000 w. 15 cts.

MARINE ENGINEERING.

NAVAL AFFAIRS.

9684. Turret of the Battleship Massachusetts Under Fire. (Photographic reproductions, with description of an experimental test of turret, similar to the one named, under such conditions as will obtain in an actual sea fight). Sci Am—Dec. 12. 1500 w. 15 cts.

9700. The Latest American Battleships. Philip Hichborn (Describes and illustrates the special features of the Alabama Class). Eng News—Dec. 10. 1800 w. 15 cts.

9740. Cruisers with Rams. (Describes a class of cruisers now being built in the British dockyards. They are as effectively armed as ordinary cruisers, but special attention has been given to the strengthening of the ship forward, so that they may use their ram without the least fear of serious damage). Engng—Dec. 4. 1300 w. 30 cts.

9752. The Trials of the Powerful (Describes the successful series of trials of exceptional severity of Her Majesty's first-class cruiser Powerful, built and engined by the Naval Construction and Armament Co., of Barrow-in-Furness). Eng, Lond—Dec. 4. 3600 w. 30 cts.

9900. The Foudroyant and the Santa Fe. A Comparison of Then and Now. (Illustration and description of two vessels, the contrast in which exemplifies the advance which has taken place not only in warship building, but in hte whole art of mechanical construction). Sci Am Sup—Dec. 19. 1200 w. 15 cts.

9951. The Russian Volunteer S. S. "Kherson." (Illustrated description). Engng—Dec. 11. 2000 w. 30 cts.

9998. The New Torpedo Craft of the United States Navy. R. G. Skerrett (Illustrated description, with table giving general particulars and principal dimensions of the boat). Harper's Weekly—Dec. 26, 1896. 1200 w. 15 cts.

10002. Secretary Herbert's Report on the Texas (Editorial criticism of the report). Sci Am—Dec. 26, 1896. 1500 w. 15 cts.

10005. Armor for Fortifications. From Der Stein der Weisen (Showing how armor has become more and more indispensable on account of the development of projectiles, and how the struggle between guns and armor is no longer restricted to naval warfare). Sci Am—Dec. 26, 1896. 1400 w. 15 cts.

10038. Her Majesty's Battleship Prince George. (An illustrated description of this great battleship, which is one of a series of nine similar vessels). Eng Lond—Dec. 18, 1896. 18000 w. 30 cts.

10154. The Machinery of the SS. Kherson (Illustrated description). Engng—Dec. 25, 1896. 2500 w. 30 cts.

MISCELLANY.

9653. Progress and Promise in American Ship-Building, ... Lewis Nixon (Antagonizing the policy of freedom in the ship-building industry, and showing the dependence of the steam marine on governmental aid). Eng Mag—Jan. 4200 w. 30 cts.

9685. Turret Deck Steamers (Illustrated description of one of the latest designs of this class, which embodies the best features of the whale-back and the ordinary cargo steamer). Sci Am Sup—Dec. 12. 500 w. 15 cts.

9739. Fiske's Helm Indicator and Steering Telegraph (Illustrated description of these two instruments, which have attained very great success in an extended series of trials in the war vessels of the United States). Engng—Dec. 4. 1400 w. 30 cts.

9754. The New P. and O. Steamship India (History of the Peninsular and Oriental Steam Navigation Company, the

oldest and largest shipping concern in existence, followed by an illustrated description of this latest addition to the company's fleet). Eng Lond—Dec. 4. 4800 w. 30 cts.

9841. The Computation of the Resistance of Ships (Berechnung des Schiffswiderstanden) Prof. Th. Maryniak (A development of a formula for computing the resistance of ships from the principles of hydrodynamics, with numerous applied examples). Zeitschr. d. Oesterr Ing u Arch Vereines. Dec. 4, 1896. 1200 w.

9935. The New Marine Power (Describes the Secor Direct Propulsion system, and the works of the company on New York Bay). Sea—Dec. 17. 1500 w. 15 cts.

9956. Canal, River and Lake Communication and Mercantile Marine in Hungary (History of water communication in Hungary, and of what has recently been done to facilitate water transport). Eng Lond—Dec. 11. 4000 w. 30 cts.

10004. The Hudson River Steamer Adirondack, of the People's Line (Illustrated description). Sci Am—Dec. 26, 1896. 1700 w. 15 cts.

10083. New Electric Bell Buoy in Boston Harbor (Illustrated description of three buoys placed along the deep-water channel in Boston harbor. They are connected with and generated from Castle Island. The principles are explained). Elec Eng—Dec. 30, 1896. 1400 w. 15 cts.

10155. Shipbuilding and Marine Engineering in 1896 (Review of the year in the United Kingdom). Engng—Dec. 25, 1896. 3200 w. 30 cts.

10182. Unification of Time at Sea (An attempt to explain why the change of time recommended by Sir John Herschel nearly a half century ago has not become an accomplished fact, and why it has hitherto attracted so little attention and received so little consideration). Trans—Dec. 25, 1896. 2500 w. 30 cts.

10265. A New Submarine Boat (Illustrated description of an invention of Mr. Simon Lake. The Columbia Iron Works, of Baltimore, are to build the boat for experimental work. Compressed air and electricity enter largely into its operation). Mfrs Rec—Jan. 8, 1897. 1000 w. 15 cts.

MECHANICAL ENGINEERING.

BOILERS, FURNACES AND FIRING.

9676. Boiler Explosion of the Centralia Colliery, Centralia, Pa. (Illustrated description). Power—Dec. 700 w. 15 cts.

9755. Internal Corrosion in Steam Boilers. (Report of paper by Mr. Sinclair Couper, read before the Inst. of Engs. and Shipbuilders in Scotland. Deals with the many theories which have been adduced to account for corrosion). Eng, Lond—Dec. 4. 3,500 w. 30 cts.

9942. Boiler Efficiency, Capacity and Smokelessness, with Low-Grade Fuels. William H. Bryan (Discusses the best method of expressing the economic performance of a boiler, the ways it may be measured, table with abstract of the results of a number of boiler trials, &c). Jour of Assn of Engng Soc—Nov. 3500 w. 30 cts.

9957. Experiments with Superheated and Saturated Steam in a 500 Indicated Horse-Power Sulzer Compound Engine. B. Donkin (Summary of experiments undertaken at a cotton mill in Bavaria to test a separately fired Schwoerer superheater supplying steam to a compound condensing Sulzer engine). Eng Lond—Dec. 11. 1600 w. 30 cts.

10010. Heat Transmission Through Metal Cylinders. Lieut.-Col. English and Bryan Donkin (Results of a series of trials to ascertain the actual temperatures in the interior of the metal, to observe the exact appearance of the film of water deposited, and to determine whether such a phenomenon as cloudy steam really exists. General arrangement of the apparatus is illustrated. Engng—Dec. 18, 1896. 3000 w. 30 cts.

10040. Government Boiler Inspection (Editorial comment on the effort to promote a bill in Parliament to provide for the compulsory inspection of steam boilers. Thinks such inspection might prove mischievous, and that it is very unlikely that it would be of service). Eng Lond—Dec. 18, 1896. 1,500 w. 30 cts.

10101. Comparative Cost of English and American Boilers (Data received from Mr. George I. Rockwood, who has recently returned from Europe, concerning the relative prices of steam boilers in England and in the United States, illustrating the wide difference in the practice of the two countries). Eng News—Dec. 31, 1896. 1,300 w. 15 cts.

10139. Beekman Automatic Forced Draft Apparatus (Describes a system of furnishing forced draft to steam boiler furnaces by means of one or more fans driven by engines). Mas St Fit—Dec., 1896. 1,800 w. 15 cts.

10263. Systematic Boiler Designing. H. M. Morris (An article intending to point out the line along which engineers think and work in this branch, indicating the mode of procedure from start to finish when considering the design of a com-

plete boiler). Mach—Jan., 1897. Serial, 1st part. 2,000 w. 15 cts.

COMPRESSED AIR.

9658. The Rise of the Young Giant, Compressed Air, Ill. Curtis W. Shields (Reviewing the ever-increasing applications of compressed air as a motive power). Eng Mag—Jan. 4300 w. 30 cts.

9778. The Use of Compressed Air at a Blast Furnace Plant. Ralph H. Sweetser (Illustrated description of the plant of a furnace of the Maryland Steel Co., Sparrow's Point, Md., which has been used with much success during the past year). Compressed Air—Dec. 1000 w. 15 cts.

9790. Compressed Air; Its Generation, Transmission and Application, with Special Reference to Its Use in Railroad Shops. Curtis W. Shields (Presents in a brief form some of the more important facts concerning the methods of generating compressed air, laws governing air compressing, &c. Illustrations and discussion). New York RR Club—Nov. 19. 15500 w. 45 cts.

9904. A Light-Ship Compressed Air Plant (Illustrated description of plant upon lightship No. 42). Am Mach—Dec. 17. 1200 w. 15 cts.

9967. Some of the Uses and Advantages of Compressed Air. J. H. McConnell (Read before the Western Ry. Club. Shows the rapid progress made in the application of compressed air to railway shop work). Ry Rev—Dec. 19. 2300 w. 15 cts.

9993. Compressed Air in Railway Work. William S. Aldrich (Reviews its application to street railway work, mine haulage, motive power, &c. Considers a combined system for street railway work desirable). Am Elect'n—Dec., 1896. 2800 w. 15 cts.

9999. Economy in Compressed Air. Curtis W. Shields (Comparison between air pumps and compressors, with use and advantages of compressors). Engng Mech—Dec., 1896. 1800 w. 30 cts.

10094. Compressed Air Recoil Cylinders for Heavy Mortars (Illustrated description of design by H. A. Spiller). Sci Am—Jan. 2, 1897. 600 w. 15 cts.

10219. Economical Uses of Compressed Air. J. H. McConnell, at Western Railway Club (The many uses of air in machine shops, with special notice of certain uses and comment on the progress). Loc Engng—Jan., 1897. 1,000 w. 30 cts.

10264. Compressed Air for Hoisting Purposes. John L. Klindworth (Favoring the use of air hoists and calling attention to special points). Mach—Jan., 1897. 1400 w. 15 cts.

10266. Compressed Air for City and Suburban Traction. Herman Haupt (Presents the subjects of air motors, briefly stating some of the properties of air and the laws that govern its compression, expansion and distribution; also such properties of steam as enter into the consideration of the questions at issue). Jour Fr Inst—Jan. Serial. 1st part. 4,500 w. 45 cts.

ENGINES AND MOTORS.

9683. Benzine Motor Cycle (An illustrated description of a machine made in Munich, Bavaria, and brought to this country by Mr. Henry Hirsch). Sci Am—Dec. 12. 1800 w. 15 cts.

9722. Internal Combustion Engines. C. W. Hart and C. H. Parr (A thesis submitted for the degree of B. S. in mechanical engineering. Reviews briefly the experimental period of gas engines and discusses some of the applications. A few engines are illustrated and described. Covers the most important work which has been done in developing the internal combustion engine). Wis Eng—Oct Serial, 1st part. 3500 w. 45 cts.

9750. The Motor Car in England in 1896 (Considers the characteristic features of the motor car of 1896, as shown in England. Considers it very far from possible perfection). Eng Lond—Dec. 4. 2000 w. 30 cts.

9756. On the Use of Steam Engines. W. H. Hoffman (Lecture before Boston No. 12, N. A. S. E. as reported by A. J. Guernsey. Notes of the design, construction and use of steam engines). Safety V—Dec. 1600 w. 15 cts.

9757. Setting the Valves of the Brown Engine. Thomas Hawley (An article written some time ago and published by request of the educational committee of the various N. A. S. E. associations. Illustrated description of the Brown engine with directions for setting the valves). Safety V—Dec. 2500 w. 15 cts.

9762. Electrically Controlled Gas Motor (Illustrated description of an electrically controlled gas engine or motor, devised primarily for use in automatic railroad signals, but adapted to any purpose requiring a periodical motor). Ir Tr Rev—Dec. 10. 1600 w. 15 cts.

9852. Turbines and Their Regulators Exhibited at Geneva (Die Turbinen und deren Regulatoren auf der Schweiz. Landesausstellung in Genf 1896). Franz Prásil (A most valuable series of illustrated articles describing the latest forms of Swiss turbines and governors. Seven articles, with many illustrations). Schweizerisches Bauzeitung—Nov. 14, 21 and 28, and Dec. 5, 12, 19 and 26. 16,000 w.

9905. Safety Stop Attachment for Power-House Engines (Illustrates the attachment applied by the E. P. Allis Co. to the engines driving the electric generators of the Lenox avenue line of the Metropolitan Traction Co. of N. Y. They are equally applicable to engines doing other duty). Am Mach—Dec. 17. 450 w. 15 cts.

10001. The Use of Acetylene for Motors (An abstract translation of article by A Von lhering in the "Journal für Gasbeleuchtung." A summary of researches by himself and others in the use of acetylene in gas motors). Jour Gas Lgt—Dec. 15 1896. 700 w. 30 cts.

10008. Triple-Expansion Pumping Engine (Illustrated description of pumping plant, designed by B. V. Nordberg, to do certain work outlined by the Commissioners of the District of Columbia, U. S. A.). Engng—Dec. 18, 1896. Serial. 1st part. 2500 w. 30 cts.

10031. Neutral and Reverse Compounding. Charles M. Jones (Showing that cylinders of equal volume may be compounded in single series, and that engines may be constructed in which the higher pressured cylinders are of greater volume than the cylinders which they supply with steam). Eng—Dec. 19, 1896. 1,200 w. 15 cts.

10066. Compression as a Factor in Good Running Engines (Shows the benefit of compression in a condensing engine, as well as a non-condensing, if the compression is properly obtained). Eng Rec—Dec. 26, 1896. 500 w. 15 cts.

10146. Vertical Compound Engine at Warren, R. I. (Illustrated description of new engine). Power—Jan., 1897. 600 w. 15 cts.

10224. A Novel Engine Design (Illustrated description of a novel steam engine designed by L. Hollingsworth, Jr.). Am Mach—Jan. 7, 1897. 1,000 w. 15 cts.

10259. Designing an Engine Shaft Governor. Theo. F. Scheffler, Jr. (General description of the governor and the mechanical theory, showing how it controls the steam valve; followed by details). Mach—Jan., 1897. Serial. 1st part. 2000 w. 15 cts.

POWER AND TRANSMISSION.

9697. Power from the Tides (Gives illustrated description of a tidal motor, the invention of Edward Davies, and explains the working of the arrangement). Can Eng—Dec. 1,700 w. 15 cts.

SHOP AND FOUNDRY.

9660. Tests of Novel Types of Ball Bearings (Presents the result of tests made by George D. Rice, of Medford, Mass., of several types of ball bearings, with illustrations). Ir Age—Dec. 10. 1000 w. 15 cts.

9671. A. 57-Inch Lathe (Describes an interesting lathe recently built for the Union Iron Works, San Francisco. Two half tones and the plan, elevation and cross-section give a good idea of the lathe). Am Mach—Dec. 10. 600 w. 15 cts.

9672. A Diagram for Determining Diameters of Solid Round Shafts Subject to Bending and Twisting, and Arrangement of Drawing-Room Bluebook. Henry Hess (Diagram, with directions for use, and example). Am Mach—Dec. 10. 1000 w. 15 cts.

9763. Utility of the Test Bar and Standard Systems for Comparative Tests. Thomas D. West (Read before the Foundrymen's Assn. Calls attention to various points in tests presented, and shows that the true utility of the test bar is simply comparative). Ir Tr Rev—Dec. 10. 2000 w. 15 cts.

9902. Cycle Stampings. Hugh Dolnar (Illustrated description of work and one set of tools of Matthews Co., of Seymour, Conn.). Am Mach—Dec. 17. 2800 w. 15 cts.

10028. Economical Production in Engineering Workshops (An effort to show how to produce work at the lowest possible cost, without any drawbacks). Mach, Lond—Dec. 15, 1896. Serial. 1st part. 1700 w. 30 cts.

10089. Accurate Work on Lathe and Planer by Use of Solder. A. H. Cleaves (Illustrated description of methods). Am Mach—Dec. 31, 1896. 1000 w. 15 cts.

10090. Special Drives. John Randol (Presents the convenience and economy of arranging some means by which power can be delivered at any place on the shop floor where it is required). Am Mach—Dec. 31, 1896. 2,300 w. 15 cts.

10127. The Founding of Statuary. Horace G. Belcher. (Illustrated description of the work as executed in the foundry of Gorham Mfg. Co., at Elmwood, near Providence, R. I. Describes also the foundry, furnaces, ovens, &c.). Foundry—Dec., 1896. 3400 w. 15 cts.

10129. The Manufacture of Charcoal for Foundry Purposes. L. S. Brown (Describes and illustrates methods of burning and calls attention to points where its use would be economical). Foundry—Dec., 1896. 2700 w. 15 cts.

10130. Physical Tests of Cast Iron in the Foundry. James A. Beckett (Showing that such tests are a necessity; discussing the transverse test, and the methods). Foundry—Dec., 1896. 1800 w. 15 cts.

10131. Down Draft Core Oven. W. L. Hayden (Part first is an illustrated description of the details above ground). Foundry — Dec., 1896. Serial. 1st part. 1200 w. 15 cts.

10132. The Arch-Enemy and How to Control It. L. C. Jewett (Discusses "vent," or the outlet for pent-up gases). Foundry—Dec., 1896. 1200 w. 15 cts.

10156. Defects in Cast-Iron Castings (A foreman moulder presents the practical aspect of the question. Emphasizes the importance of making a good mould). Engng—Dec. 25, 1896. 1500 w. 30 cts.

10223. Long Gear Teeth. Horace L. Arnold (A discussion of the subject from

a machine shop point of view). Am Mach —Jan. 7, 1897. 2000 w. 15 cts.

10229. The South's Foundry Interests. E. H. Putnam (Progress in the past the index for the outcome in the future). Tradesman—Jan. 1, 1897. 4500 w. 15 cts.

10260. Brass Foundries (Part first gives information of furnaces used). Mach—Jan., 1897. Serial. 1st part. 1300 w. 15 cts.

10261. Lathe Cones and Back Gears. R. E. Marks (Explanation of these questions which often trouble mechanics and draughtsmen). Mach—Jan., 1897. Serial, 1st part. 900 w. 15 cts.

10262. Machining Cycle Forgings. Onondaga (A description in detail of the method of machining the bottom bracket forgings, and the proper method of designing the forgings is illustrated and described, also tools and special jigs used). Mach — Jan., 1897. Serial. 1st part. 1400 w. 15 cts.

MISCELLANY.

9657. Labor-Saving Machinery, the Secret of Cheap Production. A. E. Outerbridge, Jr. (Showing that an ascending wage-scale is an essential of prosperous productivity). Eng Mag—Jan. 3,200 w. 30 cts.

9679. Insulation of Steam Pipes by Means of Zinc and Tinplate Jackets. Dr. Jsh. Russner (Translated from Wochenblatt für Papierfabrikation, showing that by a proper arrangement of zinc and sheet jackets a system of steam pipes can be as well protected against loss of heat as with the best insulating material now in use). Power—Dec. 1,100 w. 15 cts.

9680. Experimental Determination of the Efficiency of Pipe Coverings. F. G. Gasche (Explains a method of investigation, apparatus used, &c.). Power—Dec. 3,000 w. 15 cts.

9720. Abrasives. A. L. Goddard (A general review of abrasives now used and the methods employed). Wis Eng—Oct. 3,300 w. 45 cts.

9724. A Comparative Test of Steam Injectors. G. H. Trautmann (Abstract of a thesis for the degree of B. S. in mechanical engineering. The object of the work described was to test each of eight injectors according to a definite system so that they could be compared exactly in every detail carried out. Curves given show the effects of changing the feed-water temperature). Wis Eng—Oct. 1,000 w. 45 cts.

9737. Canet's Quick-Firing Field Guns (Describes the Canet new model, an important type of quick-firing gun combined with a carriage, and the different ways in which the desired conditions have been partially attained). Engng—Dec. 4. Serial, 1st part. 1,800 w. 30 cts.

9774. A Geometrical Solution of the Problem of Finding the Radii of Different Pulleys, so that the Same Open Belt Shall Fit Each and Every Pair. W. J. Varley (Solution illustrated by seven diagrams). Elec Rev, Lond—Dec. 4. 700 w. 30 cts.

9779. The Andre System of Gas Heated Ovens. P. Chevillard, in Revue Industrielle (Describes an oven used in heating iron moulds used in the manufacture of glass lenses, and considers the wider application to ovens for bakers, pastry cooks, &c. Illustrations). Am Gas Lgt Jour—Dec. 14. 2,000 w. 15 cts.

9780. The Hopeful Outlook in the Mechanical World (Testimonies of great industrial concerns regarding the condition of business since the Presidential election of 1896; a symposium). Eng Mag—Jan. 3,800 w. 30 cts.

9808. Germanisms and Americanisms in Technical Methods (Teutonismus und Amerikanismus in der Technik) (The first portion of an interesting comparison of the methods of the two nationalities. This article considers the present German practice as the result of three influences, i. e., the old "handwerk," modern "book learning" and an admixture of English methods). Deutsche Zeitschrift für Elektrotechnik—Oct. 15. 1400 w.

9835. Automatic Air Relief Device for Siphons (Automatische Entluftungs-Vorrichtung fur Heberleitungen). Rudolf Muller. (A descriptions with illustrations of the apparatus constructed for the purpose of automatically relieving the siphon in the Bielitz water supply main affair, by a system of traps and floats). Oesterr. Manatschr. f. d. Oeff. Bau—Dec. 1896. 6000 w.

9847. Machinery at the Geneva Exposition (Les Machines a l'Exposition de Genéve). (An editorial notice of the machine exhibits, including boilers, engines, hydraulic motors and machine tools). La Révue Technique—Nov. 10, 1896. 6,000 w.

9848. The Loewe Machine Tools at the Berlin Exhibition (Les Machines-Outils Loewe à l'Exposition de Berlin). (Description, with excellent illustrations, of some of the Belgian copies of American machine tools). La Révue Technique—Nov. 10, 1896. 3,500 w.

9901. Machine for Tapping Water Mains (Illustrated description of machine for cutting a hole in a main pipe and making a secure connection for a branch or outlet without shutting off the pressure). Am Mach—Dec. 17. 700 w. 15 cts.

9903. Valuation of Manufactories. Oberlin Smith (A discussion of the appraiser's work, and advocating the rating of things a little too low, rather than too high). Am Mach—Dec. 3,300 w. 15 cts.

9954. The Potential of Steam. Howard Pentland (Read before the Inst. of Civ. Engs., Ireland. Suggesting the estimating of saturated steam, expanded steam and electricity all by work, instead of by

different means). Mech Wld—Dec. 11. Serial. 1st part. 1,700 w. 30 cts.

9964. Management of Steam Plants. M. W. Danielsen (The importance of giving attention to small things). Age of St—Dec. 19. 1,400 w. 15 cts.

9979. Quartz Fibres. C. Vernon Boys (The method of making and applying quartz fibres. Instruction with practical details). Elect'n—Dec. 11, 1896. Serial. 1st part. 3,300 w. 30 cts.

9994. Friction and Lubricating Oils. C. A. Collett (The laws of friction are discussed in Part I. A succeeding article will discuss in detail the various kinds of lubricating oils). Am Elect'n—Dec., 1896. 1300 w. 15 cts.

10009. American Machine Tools (Editorial comment on the higher perfection of light machine tools made in America). Engng—Dec. 18, 1896. 1,600 w. 30 cts.

10043. Aluminum Bronze Seamless Tubing. Leonard Waldo (Describes process of making, with difficulties. Abstract of a paper presented at the N. Y. meeting of the A. S. M. E). Eng News—Dec. 24, 1896. 1,000 w. 15 cts.

10049. Status of Apprenticeship in the Trades Concerned in the Production of Machinery (Letters from 116 of the most prominent machinery building establishments and important railway systems of the country, stating their practice and views regarding apprenticeship). Am Mach—Dec. 24, 1896. 24,000 w. 15 cts.

10091. A New Formula and Diagram for Combined Stresses in Shafts. A. L. Hopkins (Explains the deduction of a formula which the writer thinks should be not only convenient for general use and permit of a graphic representation, but which would also give results agreeing closely with those obtained by the use of the Rankine and Grashof formulae). Am Mach—Dec. 31, 1896. 2,000 w. 15 cts.

10095. The New Polarizing Photo-Chronograph at the United States Artillery School, Fort Monroe, Va. Albert Cushing Crehore and George Owen Squier (Illustrated description of this instrument and its installation, with some of the further tests and experiments with it which were carried out in the electrical laboratory of the school where the new instrument was installed). Sci Am Sup. Jan. 2, 1897. 9,000 w. 15 cts.

10168. Coal Handling Machinery at the Yard of J. T. Story, Brooklyn, N. Y. Built by the C. W. Hunt Co. (Illustrated description of a successful plant with a daily capacity of 600 or 700 tons). Am Eng & RR Jour—Jan, 1897. 1,600 w. 30 cts.

10199. The Manufacture of Bicycle Tubing (Illustrated detailed description of the plant of the Pope Tube Co., of Hartford, Conn., manufacturers of steel bicycle tubing). Ir Age—Jan. 7, 1897. 4,800 w. 15 cts.

MINING AND METALLURGY.

COAL AND COKE.

9744. "Afterdamp." T. Getrych Davies (A description of its effects and some peculiar experiences with it at several explosions. From Proceedings of South Wales Inst. of Min. Engs.). Col Eng—Dec. 2,000 w. 30 cts.

9746. The Regulation of the Output of Coal in South Wales (Report of the owners' representatives on the Sliding Scale Joint Committee upon the question of the undue competition in the coal trade). Col Guard—Dec. 4. 2,800 w. 30 cts.

9946. The Westphalian Coal Field in Germany. A. Kowatsch (Descriptive account). Eng & Min Jour—Dec. 19. 1,100 w. 15 cts.

9961. Irruptions of Coal in Mine Workings. F. G. Meachem (Notes on irruptions of Hamstead Colliery, South Staffordshire, read at meeting of Manchester Geol. Soc. Suggestions as to the causes). Col Guard—Dec. 11. 1,800 w. 30 cts.

9962. The Treatment of Coal at the Pit Bank (Two papers read before the Inst. of Civ. Engs. The first, "Screening and Tipping Coal," by James Rigg; the second, "The Surface Plant at Kirkby Colliery," by Thomas Gillott. Abstracts). Col Guard—Dec. 11. 1,200 w. 30 cts.

9963. Experiments with a Ser Fan at the Saint-Eloy Colliery for Determining the Equivalent Orifice. M. de Lachapelle (From a communication to the Société de l'Industrie Minerale. Experiments made in the passage orifice of the fan drift connected with the upcast shaft). Col Guard—Dec. 11. 1,200 w. 30 cts.

10029. Coal Cutting by Machinery. W. Blakemore (A description of the machines in use at the Dominion No. 1 mine, which was especially laid out for the purpose of machine mining. Illustrated). Can Min Rev—Dec., 1896. Serial. 1st part. 3,400 w. 30 cts.

10061. A Saxon Coal Mine. E. R. Schoch (Brief description of mine, method of coal getting, &c). Eng & Min Jour—Dec. 26, 1896. 900 w. 15 cts.

10062. An Illinois "Solid-Shooting" Mine; the Virden Shaft (Illustrated description of the property of the Chicago-Virden Coal Co.). Eng & Min Jour—Dec. 26, 1896. 1,000 w. 15 cts.

10160. Nova Scotia Coals as Steam Producers. F. H. Mason and W. G. Matheson (The object of the paper is to place on record some results obtained from an

analysis of samples of coal from the various mines of Nova Scotia). Col Guard—Dec. 24, 1896, 2,300 w. 30 cts.

10181. The Coal Industry in 1896 (A review of the industry in Great Britain, shows the production to be probably the highest on record, but the prices unsatisfactory. The article deals with prices, production, labor disputes, &c). Ir & Coal Trd Rev—Dec. 24, 1896. Serial. 1st part 7,000 w. 30 cts.

10240. Coke Making and Southern Coals. John S. Kennedy (The salient points of difference between the old and the new practice). Tradesman—Jan. 1, 1897. 2,000 w. 15 cts.

10241. The Coal Interests of the South. J. J. Ormsbee (Historical and statistical review of the work of the past year). Tradesman—Jan. 1, 1897. 4,500 w. 15 cts.

10242. The Coal Interests of the South. Jesse T. Hill (A review of the mining operations in each of the Southern States. Tradesman—Jan. 1, 1897. 1800 w. 15 cts.

COPPER.

9984. The Alloys of Copper and Zinc. T. K. Rose (The researches of M. G. Charpy which have notably advanced knowledge of this subject). Nature—Dec. 10, 1896. 1,300 w. 30 cts.

10052. Copper Refining by Electricity (A brief review of the main difference between the two classes of copper-refining processes, with remarks on the lack of wisdom of copper refiners in not publishing results and comparing notes). Min & Sci Pr—Dec. 19, 1896. 1200 w. 15 cts.

GOLD AND SILVER.

9668. The Losses of Fine Gold in Gippsland. Donald Clark (An interesting description of losses in the mountainous gold field in Victoria). Aust Min Stand—Oct. 29. 4,000 w. 30 cts.

9669. The New Discoveries in Gippsland, Victoria (Late discoveries in Eastern Gippsland as reported by Reginald Murray) Aust Min Stand—Nov. 5. 1,300 w. 30 cts.

9670. Yowaka, or Pambula, Gold Field, New South Wales. J. E. Carne (Illustrated detailed description). Aust Min Stand—Nov. 5. Serial, 1st part. 5,500 w. 30 cts.

9689. The Gold Belt of Pitkin, Gunnison County, Col. J. R. Holibaugh (Describes the location and formation of the belt and some of the well-developed properties). Eng & Min Jour—Dec. 12. 900 w. 15 cts.

9741. Twin Lakes Region. J. J. Guentherodt (Description of a rich placer and gold mining district of Colorado which has been but little developed). Col Eng—Dec 1,600 w. 30 cts.

9742. The San Juan Region. Arthur Lakes (A description of a rich mining field and its developments. The Spanish peaks, the geological history, the ore deposits and mining characteristics are treated in detail). Col Eng—Dec. 5,400 w. 30 cts.

9743. Victor (Cripple Creek), Colorado. Arthur Lakes (An account of a gold-bearing vein found while excavating for the foundations of a hotel). Col Eng—Dec. 1,400 w. 30 cts.

9784. Notes on the Estimation of Sulphides and Cyanates in Commercial Cyanide. Messrs. Feldtmann and Bettel (Read at meeting of the Chemical and Metallurgical Society of South Africa. The paper deals with two of the most troublesome estimations in the analysis of cyanide—the estimation of sulphides and cyanates. The first part describes a rapid and accurate method for the estimation of sulphides). Min Jour—Dec. 5. Serial, 1st part. 1,600 w. 30 cts.

9938. The Mineral Deposits of Eastern California. Harold W. Fairbanks (This portion of California has a mineral deposit in many respects different from the rest of the State. The important deposits are gold, silver and lead). Min & Sci Pr—Dec. 12. 1,700 w. 15 cts.

9959. The Gold Fields of the Houraki Peninsula, New Zealand. Joseph Campbell (Describes the characteristics of the gold fields included in each of the counties embraced within the peninsula). Min Jour—Dec. 12. Serial. 1st part. 1,100 w. 30 cts.

9991. The West Australian Gold Occurrences. C. A. Huessler (Observation and conclusions from notes taken in the various fields while touring per bicycle). Aust Min Stand—Nov. 19, 1896. Serial. 1st part. 1,300 w. 30 cts.

10046. Mexico and Its Gold. C. C. Longridge (The increase in the gold output, and the questions of communication, water and fuel. Mexico is considered from its geological and mineralogical standpoint). Min Jour—Dec. 19, 1896. 1,300 w. 30 cts.

10047. The Latest Great Gold Discovery in the United States (The riches of the Mojave Desert in California). Min. Jour—Dec. 19, 1896. 1,800 w. 30 cts.

10072. The Ore-Shoots of Cripple Creek. Edward Skewes (An introductory contains condensed statements from the work of Messrs. Cross and Penrose as reported in the U. S. Geol Survey, and the paper then gives facts concerning the occurrence, and more particularly the pitch of the ore-shoots in the locality). Trans Am Inst of Min Engs—Dec. 1896. 8,500 w. 45 cts.

10073. The Solution and Precipitation of the Cyanide of Gold. S. B. Christy (A discussion of how gold dissolves in cyanide solutions, and how it is precipitated from them. The results of a systematic investigation). Trans Am Inst of

Min Engs—Dec., 1896. 14,000 w. 45 cts.

10148. Gold and Silver (Review of 1896 in the production of these metals, and a comparison with 1895. Gold mining in the South and in Cripple Creek, Leadville, Mexico and other countries are separately treated). Eng & Min Jour—Jan. 2, 1897. 9,500 w. 15 cts.

10230. Metallurgy of Southern Gold. William M. Bowron (The field that was worked in every section prior to the exodus of '49). Tradesman—Jan. 1, 1897. 4,000 w. 15 cts.

IRON AND STEEL.

9661. Four American Rolling Mills. Samuel T. Wellman (Paper read before the Inst. of Civ. Engs. of Great Britain. The author deals more particularly with the machinery and appliances, to save labor and time in handling the piece round the rolls, which have been introduced within the past 10 or 11 years. Illustrated description is given of appliances used in the Joliet Works of the Illinois Steel Co., the South Works of the Illinois Steel Co., South Chicago, Ill.; the new rail mill at the Edgar Thomson Steel Works, the plate mill of the Illinois Steel Co., South Chicago). Ir Age—Dec. 10. 4000 w. 15 cts.

9687. Evidence for the Allotropic Theory. Henry M. Howe (Describes experiments made to get light on the effect of allotropy as contributing to the hardening of steel and in the question of stress). Eng & Min Jour—Dec. 12. 800 w. 15 cts.

9851. The Metamorphoses of the Basic Steel Process and the Methods of Testing Steel Rails (Metamorphosen der Basischen Schienenstahlbereitung und des Prufungsverfahrens der Stahlschienen. Prof. L. Tetmaier (A discussion of the basic steel process, especially with regard to its use for rails. Also many illustrations of etched rail sections, showing structure. Five articles). Schweiz Bauzeitung—Nov. 7, 14, 21, 28 and Dec. 12, 1896. 15,000 w.

9953. American and English Methods of Manufacturing Steel Plates. Jeremiah Head (Read before the Inst. of Civ. Engs. Illustrated discussion of the processes used and comparison of methods). Ir Age—Dec. 24. 8,000 w. 15 cts.

10021. The Determination of Sulphur in Cast Iron. Francis C. Phillips (Investigation to ascertain as far as possible whether by a process of direct oxidation of the iron in a dry state a larger proportion of the sulphur could be recovered in weighable form than by the usual method of oxidation and solution in nitric acid). Jour Am Chem Soc—Dec., 1896. 2,200 w. 45 cts.

10022. Carbon Determinations in Pig Iron. Bertrand S. Summers (Illustrated description of apparatus by which the carbon may be determined with reasonable speed and accuracy). Jour Am Chem Soc—Dec., 1896. 900 w. 45 cts.

10030. The Bertrand-Thiel Steel-Making Process. Percy C. Gilchrist (Read at meeting of the Cleveland Institution of Engineers. The process is briefly stated and the results given. Discussion follows). Iron and Coal Trds Rev—Dec. 18, 1896. 2,300 w. 30 cts.

10033. The Lease of the Mountain Iron Mine (Recent arrangements made by the Carnegie Steel Co., Ltd., with editorial comment). Ir Tr Rev—Dec 24, 1896. 2,500 w. 15 cts.

10058. The Testing of Iron and Steel (Introduction to paper by Prof. J. B. Johnson presented at meeting of the St. Louis Ry. Club, with conclusions based on actual tests). R R Gaz—Dec. 25, 1896. 1,900 w. 15 cts.

10063. Residual Stresses in Steel. H. K. Landis (Explains the meaning of the term and the influence; gives a table of effect of cold and hot rolling on endurance; shows that hot rolled bars are less strong and tough than the same material after cold working, &c). Am Mfr & Ir Wld—Dec. 25, 1896. 1,500 w. 15 cts.

10064. Cast Steel in Locomotive Building (Extract from paper by Mr. Barba read before the New England Ry. Club, showing the adaptation of steel to this work). Am Mfr & Ir Wld—Dec. 25, 1896. 1,300 w. 15 cts.

10067. Cast Steel in Locomotive Construction. J. E. Sague (Extract from a paper read before the New England Ry. Club. Reasons which have led to the wide substitution of steel for cast and wrought iron). Ry Rev—Dec. 26, 1896. 2000 w. 15 cts.

10088. Constitution and Properties of Cast Iron. A. J. Rossi (An examination of parts of an article by A. Pourcel, a well-known French metallurgist, published in "Revue des Sciences"). Ir Age—Dec. 31, 1896. 3,000 w. 15 cts.

10128. Carbon in Iron. S. S. Knight (Comments on the slow progress in the chemical and scientific components of the iron industry. Considers the subject of carbon in its relation to iron, and gives the results of experiments). Foundry—Dec., 1896. 1,400 w. 15 cts.

10135. 1896 in the Iron Trade (Review of the production and prices for the year). Ir Tr Rev—Dec. 31, 1896. 1,700 w. 15 cts.

10140. First Principles of Steel Specifications. H. K. Landis (Arguing that a specification defining the qualities which the purchaser desires is not sufficient, but a clause should be added describing the purpose for which the material is intended). Am Mfr & Ir Wld—Jan. 1, 1897. 1,400 w. 15 cts.

10149. The Course of the Iron Markets in 1896 (Yearly review which notes many important changes and fluctuations).

Eng & Min Jour—Jan. 2, 1897. 8,200 w. 15 cts.

10170. The Progress in the Manufacture of Iron and Steel in America and the Relations of the Engineer to It. John Fritz (Presidential address presented at the N. Y. meeting, Dec., 1896, of the Am. Soc. of Mech Engs. Part first gives a brief account from its infancy to 1895, and a succeeding article will show the wonderful changes since that time). Am Eng & R R Jour—Jan., 1897. 2500 w. 30 cts.

10174. The Swedish Iron, Steel and Coal Industries in 1895 (A résumé taken from the official report just issued). Eng Lond—Dec. 25, 1896. 1,400 w. 30 cts.

10180. The Iron and Steel Trades in 1896 (Yearly review of these industries in the United Kingdom show advances both absolute and relative). Ir & Coal Trds Rev—Dec. 24, 1896. 3,000 w. 30 cts.

10200. The "Kearsage" and "Kentucky" Plates. W. L. C. (Report of Acting-Secretary McAdoo's views, the report of the Steel Board and comments of Chief Hichborn, of the Bureau of Construction). Ir Age—Jan. 7, 1897. 2,800 w. 15 cts.

10201. The Manufacture and Use of Thomas Slag. F. E. Thompson (This basic slag is the scoria produced in Bessemerizing phosphoritic pig iron according to the patents of Messrs. Thomas & Gilchrist. Its production, chemistry, analysis and use are discussed). Ir Age—Jan. 7, 1897. 4,200 w. 15 cts.

10202. The Pittsburg Iron Trade in 1896 (Review of the year, also discusses in detail the trade in pig iron, steel billets, finished iron and steel, plates and bars). Ir Age—Jan. 7, 1897. 7,400 w. 15 cts.

10203. The Cost of Armor Plate (Summary of Secretary Herbert's letter to Congress). Ir Age—Jan. 7, 1897. 4,000 w. 15 cts.

10226. The Southern Iron Trade. William B. Phillips (Discusses the course with reference to the inspection of materials). Tradesman—Jan. 1, 1897. 10,000 w. 15 cts.

10227. The Bessemer Process. A. M. Shook (The ability of the South to manufacture basic open hearth steel is demonstrated). Tradesman—Jan. 1, 1897. 2500 w. 15 cts.

10228. The Pig Iron Trade. T. P. Wells (A retrospect of its movements in the South in the past year). Tradesman—Jan. 1, 1897. 1,000 w. 15 cts.

10244. Nickel Steel. H. K. Landis (The history, physical and mechanical properties, and the application of this metal). Sci Am—Jan. 9, 1897. 1,800 w. 15 cts.

MINING.

9736. Electricity vs. Compressed Air. Actual Results in a Mine of the Colorado Fuel and Iron Company. Lewis Searing (Practical tests of both systems made under the direction of the writer. Favorable to electricity). Min Ind & Rev—Dec. 10. 2,200 w. 15 cts.

9745. Mining Rights in Germany and Austria-Hungary (Particulars with regard to mining rights in Prussia from the official report by Mr. C. Fortescue-Brickdale. The information was collected at Beuthen, in Silesia, the centre of one of the largest mining districts). Col Guard—Dec. 4. 1,100 w. 30 cts.

9747. The Rise and Progress of Coal Mining. J. B. Simpson (Address delivered before the Newcastle Assn. of Students connected with the Inst. of Civ. Engs. A history of the progress made in the engineering of mines). Col Guard—Dec. 4. 6,000 w. 30 cts.

9748. Use of Expansion in Winding Engines. M. Berne (From a communication to the Societe de l'Industrie Minerale, St. Etienne. The advantages and results in the use of expansion are given). Col Guard—Dec. 4. 3,500 w. 30 cts.

9749. Electric Coal Cutting on Longwall Faces. T. B. A. Clarke (The writer describes briefly the method and apparatus employed in cutting coal electrically; compares electricity as a motive power with compressed air, and gives some results obtained in seams of various thickness by electrically driven machines). Col Guard—Dec. 4, 1,700 w. 30 cts.

9785. Outlines of the Mexican Mining Code. C. C. Longridge. (The introduction of this code is said to have very much simplified mining business, and greatly diminished the occasions for misunderstanding and litigation.) Min Jour—Dec. 5. 1,600 w. 30 cts.

9911. Mining in the Leadville District. Franklin Ballou, Jr. (Interesting account of the marvellous mineral wealth to be found in a single square mile, with brief description of the region and the origin of the deposits). Yale Sci M—Dec. 2,400 w. 30 cts.

9945. The Limonites of Alabama Geologically Considered. Henry McCalley (Description of deposits and their location). Eng & Min Jour—Dec. 19. 1,500 w. 15 cts.

9977. Mining at Great Depths. Bennett H. Brough (An elaborate paper discussing all phases of the subject. It gives a summary of existing literature on the subject and observations of the writer). Jour Soc of Arts—Dec. 11, 1896. 11,400 w. 30 cts.

10035. Mechanical Haulage with Electric Transmission of Power. M. Dickmann (Illustrated description of two mechanical haulage plants with electric transmission of power at the Heintzmann

shaft). Col Guard—Dec. 18, 1896. 2,000 w. 30 cts.

10051. A Colorado Comparison Between Cripple Creek and the Comstock (Reprint of an article from the Denver Republican, with editorial comment on the impossibility of drawing a fair parallel between the two regions). Min & Sci Pr —Dec. 19. 3,000 w. 15 cts.

10074. The Phosphate Deposits of Arkansas. John C. Branner (Describes position, appearance and origin of the deposits, with local details, value and method of mining). Trans Am Inst of Min Engs—Dec., 1896. 6,300 w. 45 cts.

10105. Timber and Wood Consumption in the Comstock Mines. William Alvord (Statistics of the immense amount of costly timbering required and interesting information regarding it. Abstract of a paper in Vol. X of the Pro. of the Am. Forestry Assn.). Eng News—Dec. 31, 1896. 2,800 w. 15 cts.

10142. Is It Profitable to Mine Thin Seams of Coal by Any of the Types of Electrical Mining Machines Now in Use? George Gould (Concludes that it is not profitable unless conditions are favorable, and gives experience). Am Mfr & Ir Wld —Jan. 1, 1897. 1,200 w. 15 cts.

10153. The Mining Stock Exchanges in 1896 (Reports from all the leading exchanges in which there are dealings in American mining stocks). Eng & Min Jour—Jan. 2, 1897. 12,500 w. 15 cts.

10159. Mining Law of Foreign Countries (Reviews and compares the laws of different lands). Col Guard—Dec. 24, 1896. 1,600 w. 30 cts.

10162. Explosives in Coal Mines (Order made by the Sec. of State for the Home Dept.—cited as the Explosives in Coal Mines Order, 1896). Col. Guard—Dec. 24, 1896. 2800 w. 30 cts.

10236. The Mineral Industry of the South. William M. Brewer (Activity in prospecting shows a marked improvement over 1895. Each mineral is briefly discussed). Tradesman—Jan. 1, 1897. 4000 w. 15 cts.

10237. The Manganese Ores of Georgia. William M. Brewer (A mining and shipping industry that has been in operation for over half a century. The system of working is described). Tradesman—Jan. 1, 1897. 2,000 w. 15 cts.

10245. Hoisting Engines for the Anaconda Mine (Illustrated description of the compound hoisting engines—high-pressure cylinder 26 inches diameter, low-pressure cylinders 46 inches diameter, stroke 72 inches). Sci Am—Jan. 9, 1897. 700 w. 15 cts.

MISCELLANY.

9654. The Prospective Resumption of Mining Activity. David T. Day (Reviewing the stagnant condition of the mining industry and its responsiveness to improved economic conditions and processes). Eng Mag—Jan. 4,300 w. 30 cts.

9662. Aluminum Manufacture in Europe. Alfred E. Hunt (Reviews the history of aluminum manufacture, with the processes used, and gives information regarding prices and development). Ir Age —Dec. 10. 3,000 w. 15 cts.

9667. Zinciferous Ores (A detailed description of the F. L. Bartlett process of treatment). Aust Min Stand—Oct. 29. 900 w 30 cts.

9795. The Use of Oxygen in Gaseous Poisoning (Part first is an illustrated description of preventive and rescuing appliances, and will be followed by a code of rules). Pro Age—Dec. 15. 3,500 w. 15 cts.

9948. Value of Different Kinds of Stone Produced in 1894 and 1895. William C. Day (Part first gives particulars of the marble industry in the various States, with the value of the marble produced). Stone—Dec. Serial. 1st part. 1,100 w. 30 cts.

9949. Geology for Quarrymen. Charles Richard Van Hise (Reprinted from 16th Annual Rept. U. S. Geol Soc. Illustrated review of the causes assigned for joints, zone affected by them, their relation to stratigraphy, faults, folds, &c). Stone—Dec. 3,600 w. 30 cts.

9950. Minnesota Sandstones. N. H. Winchell (Extract from Geol and Nat Hist Survey of Minnesota. Descriptive). Stone—Dec. 2,000 w. 30 cts.

9960. The Mineral Industry of the United Kingdom. C. Le Neve Foster (From the second annual report for the year 1895) Col Guard—Dec. 11. 1,800 w. 30 cts.

10020. Metal Separations by Means of Hydrochloric Acid Gas. J. Bird Moyer (From author's thesis presented to the Faculty of the Univ. of Penn. for the degree of Doctor of Philosophy. Investigation of the action of hydrochloric acid gas upon metallic oxides and their salts). Jour Am Chem Soc.—Dec., 1896. 4,400 w. 45 cts.

10070.—Magnetic Observations in Geological Mapping. Henry Lloyd Smyth (The results of experience in tracing magnetic rocks by means of the disturbances produced in the magnetic instruments used. The rocks mapped were the pre-Cambrian rocks, particularly the iron-bearing formations of Algonkian or Huronian age). Trans Am Inst of Min Engs—Dec., 1896. 21,400 w. 45 cts.

10071. The Use of the Tremain Steam-Stamp with Amalgamation. Edwin A. Sperry (Vertical sections and description of the Tremain steam-stamp, with points of interest in regard to mill-practice in this line). Trans Am Inst of Min Engs—Dec., 1896. 2,400 w. 45 cts.

10075. Traces of Organic Remains from the Huronian (?) Series, at Iron Mountain, Mich., etc. W. S. Gresley (Illustrated description of traces of fossils discovered). Trans Am Inst of Min Engs—Dec., 1896. 3000 w. 45 cts.

10096. Gem Fields of the World. George F. Kunz (Information of the localities where different gems are found and of the methods of mining). Sci Am Sup—Jan. 2, 1897. 2,200 w. 15 cts.

10141. Action of Blast Furnace Gases Upon Various Kinds of Ores. F. E. Bachman (Additional information given in discussion of paper on this subject by O. O. Laudig, from Trans Am Inst of Min Engs). Am Mfr and Ir Wld—Jan. 1, 1897. 2,500 w. 15 cts.

10147. United States Mineral and Metal Production in 1896 (Review of the year in the production of minerals and metals, with table; also antimony and copper in this and other countries, as to production, value, &c.). Eng & Min Jour—Jan. 2, 1897. 4,500 w. 15 cts.

10150. The Mineral Industries in the South. W. M. Brewer (Sketch of progress in the mineral-bearing sections of Georgia and Alabama). Eng & Min Jour—Jan. 2, 1897. 1,800 w. 15 cts.

10151. Lead and Other Minerals (Reviews the market for 1896 in lead, nickel, quicksilver, tin, zinc and coal). Eng & Min Jour—Jan. 2, 1897. 11,800 W. 15 cts.

10246. To Experiment with Different Alloys for Coinage (Brief account of experiments being conducted at the Mint in Philadelphia). Sci Am Sup—Jan. 9, 1897. 600 w. 15 cts.

MUNICIPAL ENGINEERING.

GAS SUPPLY.

9692. Some Notes on the Comparative Cost of Supplying Light by Gas and Electricity in Manchester. G. E. Stevenson (Read before the Manchester District Inst of Gas Engs. Generally favorable to the gas industry. Followed by discussion). Jour. of Gas Lgt.—Dec. 1. 6,000 w. 30 cts.

9693. Illuminating Power as Exhibited in the Parliamentary Returns. Thomas Newbigging (Read before the Manchester Dist. Inst. of Gas Engs. Investigations made with a view to ascertaining the money value of the concession made to the gas consumer). Jour Gas Lgt—Dec. 1. 1,200 w. 30 cts.

9694. Notes on Sulphate of Ammonia. T. N. Ritson (The importance of the product in agriculture, and the need of spreading information on this subject, with tables and diagram giving the relative prices of sulphate of ammonia and nitrate of soda from 1890 to 1895). Jour Gas Lgt—Dec. 1. 2,200 w. 30 cts.

9914. Some Plain Words About City Gas Supplies (Discusses the bad system of managing this business as manifested in Boston, Brooklyn and New York, and suggests the principles on which the supply of a city should be managed). Eng News—Dec. 17. 2,000 w. 15 cts.

9936. Discussion of Mr. Newbigging's Paper on "Illuminating Power as Exhibited in the Parliamentary Returns." Jour Gas Lgt—Dec. 8. 2,400 w. 30 cts.

GAS SUPPLY.

9937. Discussion of Mr. Ritson's paper on "Sulphate of Ammonia." Jour of Gas Lgt—Dec 8, 2,300 w. 30 cts.

9943. Gas Producers and the Mechanical Handling of Fuel for Same. C. L. Saunders (Discusses the rapidity with which producer gas is gaining recognition, the types of producers, processes and the important questions and details necessary to efficiency). Jour of Assn of Engng Soc—Nov. 2,200 w. 30 cts.

9955. Acetylene Gas (Information derived from sources believed to be reliable. Partly abstracted from a pamphlet issued by the Acetylene Illuminating Co. History and causes of danger). Eng Lond—Dec. 11. 1,300 w. 30 cts.

10123. Elusive Leakages from Mains and Services. H. Tobey (Read before the North of England Gas Managers' Assn. Experience of the writer in tracing leakages to their source). Gas Engs' Mag—Dec. 10, 1896. 2,500 w. 30 cts.

10124. The Permanency of Illuminating Gas. William Young (Read before the N. Brit. Assn of Gas Managers. Discusses on what the permanency depends, refers to the Aitken and Young system of condensing crude coal gases, &c). Gas Engs' Mag—Dec 10, 1896. Serial. 1st part. 2,800 w. 30 cts.

SEWERAGE.

9711. The Treatment of Sewage by Chemicals in Perfect Solution. Herbert Henry Law (Read at the Newcastle Congress of the Sanitary Inst. Brief statement of difficulties, and short description of proposed treatment at Oldham). San Plumb—Dec. 1. 1,000 w. 15 cts.

9735. Sewage Irrigation in Europe and America. H. Alfred Roechling (Read at the Congress of the Sanitary Inst., Newcastle. The term "sewage irrigation" as used includes all forms of applying sewage to land. Part first is a general consideration of the subject). San Rec—Dec. 4. Serial. 1st part. 1,800 w. 30 cts.

9751. Manchester Sewage Disposal Scheme (Discusses the modified scheme now adopted). Eng Lond—Dec. 4. 2,000 w. 30 cts.

9928. The Philadelphia & Reading Railroad Subway and Tunnel in Philadelphia. Walter Atlee (Illustrated description of the reconstruction of the sewer system in the portion of the city necessitated by the change of grade. New sewers were required in the heart of the city, almost entirely built up, and it was decided wherever practicable to build them in the tunnel. 63½ per cent. of the whole work was carried on in tunnel). RR Gaz—Dec. 18. 1,400 w. 15 cts.

9978. An Experiment in Sewage Treatment. (The suggestion of W. J. Dibdin, and the trial made. The cultivation of sewage-devouring bacteria). San Rec—Dec. 11, 1896. 1,100 w. 30 cts.

10026. The Ultimate Purification of Sewage. George Thudichum (Read before the Soc of Engs. Describes some of the more important features of biological filtration, with a comparison between filtration and irrigation, and results of various experiments). San Rec—Dec. 18, 1896. Serial. 1st part. 2,000 w. 30 cts.

10065. Methods for the Quantitative Determination of Bacteria in Sewage and Waters. George W. Fuller and William R. Copeland (Abstract of paper in Massachusetts State Board of Health Report for 1895, describing methods used at the experimental station at Lawrence). Eng Rec—Dec. 26, 1896. 4,000 w. 15 cts.

10115. Worcester Street Drain Syphon at Newton, Mass. H. D. Woods (Illustrated description of work made necessary by the depression of the four tracks of the Boston and Albany Railroad). Eng Rec—Jan 2, 1897. 800 w. 15 cts.

STREETS AND PAVEMENTS.

9702. A Notable Departure in Macadam Road Construction (Discusses the value of macadam roads, their cost, and wearing qualities; calls attention to an improved construction recently tried in Monmouth, Ill., which consists of a combination of brick pavement and macadam; gives cross-section). Eng News—Dec. 10. 1,600 w. 15 cts.

10013. Specifications for Cement Walks (Suggestions submitted, covering in a general way the proper methods and materials to be used in the building of cement walks). Br Build—Dec, 1896. 800 w. 30 cts.

WATER SUPPLY.

9760. The Use and Misuse of Water. R. E. W. Berrington (A paper read at the Nottingham meeting of the British Assn of Water Engs. Treats of false ideas with regard to waste, quantity of water required, stop taps, &c). Plumb & Dec—Dec. 1. 2,000 w. 30 cts.

9773. The Water Supply of the Mutual Life Insurance Building, New York City (Illustrated description). Eng Rec—Dec. 12. 1,700 w. 15 cts.

9783. The Clinton, Mass., Dam (Describes the huge dam about to be built by the Metropolitan Water Commission of Boston. It will retain the largest amount of water ever stored in any reservoir, amounting to 65,000,000,000 gallons). Fire & Water—Dec. 12. 1,300 w. 15 cts.

9793. Test of the Canandaigua City Water Works. E. Hensen and C. M. Riker (Description of plant and of tests, which were made with the object of finding the efficiency of each part and the efficiency of the whole plant). Sib. Jour of Engng—Dec. 1,000 w. 30 cts.

9827. The Water Works of the City of Bale (Das Wasserwerk der Stadt Basel). A. Markus (A detailed account of the use of ground water as a source of supply, together with a description of the new gas motor plant of the Bale waterworks. Schw Bauz—Oct. 8 and 10. Both articles, 7,000 w.

9974. Chittagong Water Supply Project. E. G. Foy (Part first is a detailed account of the need of a plentiful supply of pure water, with suggestions for obtaining it, which are declared inadequate, and the investigations commenced by the writer). Ind Engng—Nov. 14, 1896. Serial. 1st part. 1,100 w. 45 cts.

10025. The Value of Rain Water Supplies for Domestic Use in Rural Districts in Ireland. Patrick Letters (The abundant rain fall and the possibility of securing the much needed water, which has thus far been disregarded). San Rec—Dec. 18, 1896. 1,300 w. 30 cts.

10102. A Hydraulic Ram Plant for a Public Water Supply (Illustrated description of the Rife engine and account of the installation at West Reading, Pa). Eng News—Dec. 31, 1896. 1,500 w. 15 cts.

10125. Capacity of Water Works Systems in American Cities (Data regarding the capacity of systems in cities of a population of 100,000 or more are given in part first. Munic Engng—Jan., 1897. Serial, 1st part. 600 w. 30 cts.

10189. The Water Works of Cambridge, Mass. L. M. Hastings (History and description, with illustrations. Followed by discussion). Jour New Eng Water Works Assn—Dec., 1896. 4,500 w. 75 cts.

10190. How to Secure Pure Water from a Surface Water Supply. John C. Haskell (Present details observed by the writer, with the effects that he thinks them likely to produce upon a surface water supply, giving both the experimental and philosophical sides of the question. Discussion follows). Jour New Eng Water Works Assn—Dec., 1896. 9,500 w. 75 cts.

10191. Utilizing a Spring as a Source of Water Supply for a Town. Louis E. Hawes (Discusses springs in general, their formation, and the possibility of utilizing them as a source of water supply. Gives

data of two springs which been been used for town supplies). Jour New Eng Water Works—Dec., 1896. 6,300 w. 75 cts.

10192. Recent Specifications for Pumping Engines for the Water Works of the City of St. Louis, Mo. F. W. Dean (The specifications are given and discussed briefly). Jour New Eng Water Works—Dec., 1896. 10,000 w. 75 cts.

10212. On an Improvement in the Sedgwick-Rafter Method for the Microscopical Examination of Drinking Water. Daniel D. Jackson (The method of analysis is briefly described and the sources of error possible. Illustrated description is given of a new glass filter funnel constructed to obviate these errors). Tech Quar—Dec., 1896. 1,200 w. 75 cts.

10213. Experience with the Sedgwick-Rafter Method at the Biological Laboratory of the Boston Water Works. George O. Whipple (A study of the errors to determine the precision of the method as ordinarily used. The most important errors are noted). Tech Quar—Dec., 1896. 1,500 w. 75 cts.

MISCELLANY.

9758.—Municipal Playgrounds (Editorial comment on the movement of the population towards the city in both Europe and America, and the efforts being made to secure open spaces in the congested districts for the amusement and recreation of the children). Gar & For—Dec. 16. 1,100 w. 15 cts.

9850. The Bridge of the Exposition of 1900 (Note sur le Pont de l'Exposition de 1900). (A discussion of the disadvantages which further obstruction of the Seine would produce upon the river traffic on the Seine at Paris). La Révue Technique—Nov. 10, 1896. 2,500 w.

RAILROAD AFFAIRS.

NEW CONSTRUCTION.

9767. The Eaton Light Railway (Illustrated description of a line of very light construction on the Cheshire estate of the Duke of Westminster). Ry Wld—Dec. 1,000 w. 30 cts.

9845. The Operation of the Arlberg Railway (Die Betriebs-Ergebnisse der Arlbergbahn). Alfred Berg (A discussion of the expenses of construction and operation of this famous tunnel and road up to the end of 1895). Zeitschr d Oesterr Ing u Arch Vereines—Dec. 18, 1896. 1,200 w.

9985. The Kootenai Mining Country (An important railway enterprise looking to the development of this region). Ry Age—Dec. 18. 1,800 w. 15 cts.

10112. Railroad Building in 1896 (Tabular statement of lines building, new road, and the points between which the new track has been built, with editorial comment). RR Gaz—Jan. 1, 1897. 2,700 w. 15 cts.

10188. Great Northern Railway of Ceylon (Editorial review of what has been done so far and the various schemes for the future). Ind & East Eng—Dec. 5, 1896. 1,400 w. 45 cts.

EQUIPMENT AND EQUIPMENT MAINTENANCE.

9664. The New Heat Test for Car Wheels (Describes the methods of making heat tests used by the Pennsylvania Railroad, and by H. J. Small. Thinks these tests will furnish valuable information on the subject of wheels and wheel metals). RR Car Jour—Dec. 1,800 w. 15 cts.

9665. A Novel Design for a Combination Freight Car (Illustrated description of a novel design embodying the ideas of T. S. Easterbrook, of the Toledo, St. Louis and Kansas City RR). RR Car Jour—Dec. 800 w. 15 cts.

9764. Some Types of Light Railway Locomotives (Description, with drawings, of types of locomotives that have been successfully employed in Saxony and Belgium. Tabular statement of dimensions of types enumerated). Ry Wld—Dec. 1,100 w. 30 cts.

9786. Electric Train-Lighting on the Southeastern Railway (Brief remarks on improvements made in rolling stock, and general details of the train, and a description of the electric lighting gear). Elec Eng, Lond—Dec. 4. 1,400 w. 30 cts.

9839. The Korbuly Railway Journal Box (Korbuly's Achsenlager für Eisenbahnwagen). (Description and detailed drawings of a new journal box which has given excellent results on the Hungarian State Railways). Zeitsch d. Oesterr Ing u Arch Ver—Nov. 27, 1896. 1,000 w.

9926. Cast Steel in Locomotive Building (An abstract of papers and discussion at the Nov. Meeting of the New England RR. Club). RR Gaz—Dec. 18. 4,500 w. 15 cts.

9927. How to Bring the M. C. B. Standards Into Use (Letters from the members of a committee appointed to consider the question, read at meeting of the Central Ry. Club). RR Gaz—Dec. 18. 1,700 w. 15 cts.

9929. Tonnage Rating (Abstract of the report of Committee on "Recent Developments in the Tonnage System of Rating Locomotive Performance," as presented at meeting of Western Ry Club). RR Gaz—Dec. 18. 4,500 w. 15 cts.

9931. Car Ventilation (Editorial comment on the difficulties in securing good ventilation). R R Gaz—Dec. 18, 1896. 1,300 w. 15 cts.

9965. Electric Car Lighting in Austria (Summary of a paper, by W. Rayl, published in a recent number of the bulletin of the International Railway Congress. A satisfactory electric lighting equipment). Ry Rev—Dec. 19, 1896. 1400 w. 15 cts.

10055. New Ten-Wheel Freight Locomotives, Class "Q" Mexican Central Railroad (Illustrated detailed description of loccmotive designed by F. W. Johnstone). R R Gaz—Dec. 25, 1896. 1600 w. 15 cts.

10076. The Proper Operation of, Care and Instructions Concerning Light Feed Lubricators (Report of Committee of Travelling Engs. Assn., on the modern and advanced styles of double and triple feed lubricators, with discussion following). Trav Engs Assn Rept—Sept., 1896. 10,000 w. 45 cts.

10077. Would the Rating of Engines by Tons, Instead of by Cars, Decrease Train Delays and Increase the Efficiency of the Power, and What Is the Best Method of Equalizing the Difference Between Empties and Loads? (Report of committee followed by discussion. The committee sent out a series of questions, and report the answers received). Trav Engs Assn Rept—Sept., 1896. 10,000 w. 45 cts.

10078. In What Way Can the Rough Handling of Trains by the Air Brake Be Reduced to a Minimum? (Discussion on correspondence of the Trav Engs Assn, with recommendations of the committee). Trav Engs Assn Rept—Sept., 1896. 13,500 w. 45 cts.

10080. Weakness and Failures of Side and End Freight Car Doors (Report of Committee of Southern and Southwestern Railway Club). Pro. of South & So-west Ry Club—Nov. 19, 1896. 6,800 w. 45 cts.

10108. Wide Vestibuled Passenger Cars (Illustrated description of cars recently equipped for the Lake Shore & Mich. So. Ry.). RR Gaz—Jan. 1, 1897. 250 w. 15 cts.

10109. Ten-Wheel Passenger Locomotive for the Lake Shore & Michigan Southern (Engraving and specification). RR Gaz—Jan. 1, 1897. 700 w. 15 cts.

10134. The Irish Railway and Its Locomotives. G. A. Sekon (Brief historical account of the Great Northern Railway of Ireland, and illustrated description of its modern locomotives). Mech Wld—Dec. 25, 1896. 1,600 w. 30 cts.

10169. Shall the Cubic Capacity of Ordinary Box Cars be Increased? H. H. Perkins (Read before the Central R. R. Club. Traces the growth in size and advises the associate roads to agree on a maximum size and refuse to handle or haul beyond that limit). Am Eng & RR Jour—Jan., 1897. 2,000 w. 30 cts.

10218. Passenger Locomotive for the Illinois Central Railroad (Illustrated description of engine just out of the shops of the Brooks Locomotive Works, which is considered to closely approach the highest development of the eight-wheeled type). Loc Engng—Jan., 1897. 1,300 w. 30 cts.

10267. Results of the Working of Two-Cylinder Compound Locomotives on American Railways. John H. Cooper (Presents in detail results obtained during the year 1896. The data relates exclusively to comparison of performances between two-cylinder compounds and simple engines when alike in every respect except the compounding devices, and working under similar conditions). Jour Fr Inst—Jan., 1897. 900 w. 45 cts.

10278. The New Water Scoop of the Pennsylvania Railroad (Illustrations showing general arrangement, with some details). RR Gaz—Jan. 8, 1897. 700 w. 15 cts.

10280. An Electric Switching Locomotive (Illustrated description, with dimensions, of an electric locomotive in constant service switching freight cars between the main line of the N. Y., N. H. & H. RR. and a number of factories located along the river front). RR Gaz—Jan. 8, 1897. 600 w. 15 cts.

MAINTENANCE OF WAY AND STRUCTURE.

9729. A Railway Bridge and Building Department. Onward Bates (Shows the importance of the work of this department, the changing conditions that must be met by engineers, with information and advice for young engineers). Purdue Soc of Civ Engs—1896. 10000 w. 45 cts.

9797. Large Bearing Surfaces for Rail Joints (Extract from a communication by C. P. Sandberg upon the advantages of large bearing surfaces). Ry Rev—Dec. 12. 1,400 w. 15 cts.

10054. The Effect of High Speed on Track Maintenance. P. H. Dudley (Reply to query of the R. R. Gaz. on this subject, showing that it has been an important factor in raising the standard of track, hastened the introduction of heavier rails, etc.). RR Gaz—Dec. 25, 1896. 800 w. 15 cts.

10175. Steel Sleepers (Discusses the causes of the absence of unanimity on the part of railway engineers respecting the merits and demerits of metallic sleepers. Shows that in certain places they cannot be used, a possibility of the effect upon high speed, and various disadvantages are mentioned). Eng Lond—Dec. 25, 1896. 2200 w. 30 cts.

10281. New York Central Track Eleva-

tion in Park avenue, New York (Brief, illustrated description of the changes which have been made in narrowing the viaduct, with outline of previous work). RR Gaz—Jan. 8, 1897. 1700 w. 15 cts.

SIGNALLING.

9696. Grand Trunk Signalling System at Toronto (Illustrated description of the manual system). Can Eng—Dec. 700 w. 15 cts.

9717. A Semaphore for Permissive Block Signalling (Illustrated description of a semaphore signal recently devised by the National Swith and Signal Co. for giving either a permissive or an all-clear go-ahead signal, while yet not using the intermediate position, as is done with the common three position semaphore). RR Gaz—Dec. 11. 900 w. 15 cts.

9738. Signalling Arrangements at Liverpool Street Station (Illustrated description. In the size of its yard, the complexity of its junctions and cross-overs, and the number of its daily traffic movements, this station probably now takes precedence of any other railway terminus in the world). Engng—Dec. 4. 7,000 w. 30 cts.

9759. Boult's System of Railway Signalling (Describes this invention of Wilfrid S. Boult, the underlying principle of which is the employment of a long magnetic field of transverse and reversible polarity on the road, and a special collecting armature and polarized relay or equivalent for closing a battery circuit, carried by the engine through this magnetic field). Prac Eng—Dec. 4. 5,000 w. 30 cts.

10092. The Signalling System of the Broadway and Seventh Avenue Railroad (Illustrated description). Sci Am—Jan. 2, 1897. 900 w. 15 cts.

10220. The Thomas Pneumatic Switch and Signal System (Illustrated description). Loc Engng—Jan., 1897. 1,400 w. 30 cts.

TERMINALS AND YARDS.

9838. The Great Train Yard at Dresden-Friedrichstadt (Der Grosse Rangirbahnhof in Dresden-Friedrichstadt). (An account of the new train yard at Dresden, with detailed description of the system of making up trains, &c.). Zeitschr d Oesterr Ing u Arch Vereines—Dec. 25, 1896. 1,000 w.

9986. Baltimore & Ohio Improvements (Rearrangements of tracks and yards at Pittsburg. Description with plans). Ry Age—Dec. 18. 1,000 w. 15 cts.

10104. New Terminal Station of the Canadian Pacific Ry. at Montreal (Plan showing the general arrangement of tracks, &c., at the new Dalhousie Square terminal station, with brief description). Eng News—Dec. 31, 1896. 500 w. 15 cts.

10107. The new Union Terminal Station at Boston (Description with plans of a station which will be the largest in the world, and possess features which are radically new). RR Gaz—Jan. 1, 1897. Serial. 1st part. 2,400 w. 15 cts.

TRANSPORTATION.

9709. Electric Motive Power. W. H. Weston (The writer thinks where heavy trains are to be run on distances greater than a few miles, steam power is far preferable. On hauls of a few miles, hauling but one or two cars, electricity or compressed air may be an efficient motive power). Baker's Ry Mag—Nov. 2000 w. 30 cts.

9718. Fast Trains in Continental Europe. J. Pearson Pattinson (Some particulars of the fastest third-class train in France, and some German express trains with very heavy loads behind the engine). RR Gaz—Dec. 11. 500 w. 15 cts.

10037. With the East Coast "Flyer." Charles Rous-Marten (Deals with the service, shows the locomotive performances to be excellent. Describes three runs in detail). Eng Lond—Dec. 18, 1896. 2500 w. 30 cts.

10069. Rail Transportation of Live Stock in Uruguay. Humphrey Chamberlain (From a paper presented to the Inst. of Civ. Engs., England. Descriptive). Ry Rev—Dec. 26, 1896. 1800 w. 15 cts.

10114. Passenger Train Service in France in 1896. P. Maury (Discussion in detail of recent improvements). RR Gaz—Jan. 1, 1897. 700 w. 15 cts.

10238. Some Changes in the Railroad Map. J. C. Ransom (Showing how consolidation and traffic arrangements affect transportation and build up southern ports). Tradesman—Jan. 1, 1897. 4500 w. 15 cts.

10283. The Traffic Field in 1896 (Annual review of the work, looking at some facts and incidents not touched upon by the Commission of Interstate Commerce). R R Gaz—Jan. 8, 1897. 1700 w. 15 cts.

10289. Recent Developments in Rating Locomotive Performances (An abstract of a paper read before the Western Ry Club by Mr. Tracy Lyon is given. The paper is divided under several headings, and under the same headings the practice of other railways is given for the purpose of comparison). Eng News—Jan. 7, 1897. 4,500 w. 15 cts.

10293. Current Transportation Topics. Emory R. Johnson (A discussion of various topics bearing upon transportation, such as the power of the Interstate Commerce Commission to fix rates, reorganization of traffic associations, railway receiverships, &c.). An Am Acad—Jan., 1897. 4,800 w. $1.

MISCELLANY.

9568. Railway Schemes in Parliament (A general editorial review of the possible

work in prospect). Engng—Nov. 27. Serial. 1st part. 3,000 w. 30 cts.

9589. What Is a Water Brake? T. A. Hedendahl (Reply to the query). Loc Engng—Dec. 800 w. 30 cts.

9590. Water-Brake Cards, U. P. R. R. (The indicator diagrams given with description and explanation illustrate the force exerted in the cylinder as braking power, the distribution of that power throughout the stroke, and the variation of power due to the location of the reverse lever). Loc Engng—Dec. 400 w. 30 cts.

9635. Paints for Railways. M. F. Lindsay (Consideration of the necessities to produce a paint that will answer the purpose of a preservative of wood and iron). Ry Rev—Dec. 5. 2,800 w. 15 cts.

9636. Rail Top Culverts (Illustrated description of an excellent design of rail-top culvert which has proved itself to be satisfactory in service). Ry Rev—Dec. 5. 900 w. 15 cts.

9637. Interchangeable Mileage Tickets (Reprint of arguments as presented in this paper of June 4, 1892, which fairly state the case. Permission has been granted for such roads as desire to unite in the issue of such a ticket). Ry Rev—Dec. 5. 1,400 w. 15 cts.

9659. The Present and Future of American Railroads. Thomas F. Woodlock (Showing that railroads have reason to expect an increasing volume of business, and may reap a profit therefrom by avoiding waste in train mileage). Eng Mag—Jan. 4,800 w. 30 cts.

9666. Some Shop Tools (Illustrated description of a few special contrivances that are useful in railroad repair shops; tools, device for using compressed air, turntables, &c). R R Car Jour—Dec. 2,000 w. 15 cts.

9674. November's Poor Railroad Earnings (The returns the poorest for any month this year. Tables are given showing increase and decrease in each month, comparison of the month of November for the past three years, with gross earnings for November of different classes of roads). Bradstreet's—Dec. 12. 700 w. 15 cts.

9675. Little's Baltimore & Ohio Report (Mr. Stephen Little, the noted expert in railroad accounting, was employed to make an investigation of the company's financial affairs. The article comments on this report). Bradstreet's—Dec. 12. 1,100 w. 15 cts.

9681. A Wise Railroad Move (Account of a movement proposed by the Seaboard Air Line to establish 100 experimental farms along its line). Mfrs Rec—Dec. 11. 800 w. 15 cts.

9707. Economic Locomotive Management. George H. Baker (Part first deals with coal as the means of heat, and, therefore, the source of a locomotive's power. Reviews the origin of coal and the varieties). Baker's Ry Mag—Nov. 2,200 w. 30 cts.

9708. Lubrication. George L. Fowler (Lubricants and the ways of applying them are discussed. A brief review of what is known on the subject, and a few suggestions as to the considerations that should have weight in making selection of lubricants and bearing metals to be used on cars). Baker's Ry Mag—Nov. 4,000 w. 30 cts.

9710. Theory of Compound Curves in Railroad Engineering. Arnold Emch (The problem is treated from a general geometrical standpoint). Kansas Univ Qr—Oct. 1,400 w. 45 cts.

9716. Test of the Performance of a Locomotive Injector (A detailed description of the apparatus, the methods employed and some of the results that were obtained in a recent comparative test of locomotive injectors). R R Gaz—Dec. 11. 3,500 w. 15 cts.

9761. Japanese Railways. C. A. W. Pownall (Submitted to the last annual meeting of the Am. Roadmasters' Ass'n at Niagara Falls. An interesting description, with special reference to roadway and track construction). Ry Age—Dec. 11. 3,700 w. 15 cts.

9796. Coupler Knuckles (Gives the decision of the U. S. Circuit Court of Appeals in the case of Shickle, Harrison & Howard Iron Co. vs. St. Louis Car Coupler Co.). Ry Rev—Dec. 12. 2,600 w. 15 cts.

9798. Railway Schools (Facts from note by Mr. Messayedoff in the Bulletin of the International Ry Congress, describing the Russian schools). Ry Rev—Dec. 12. 1,600 w. 15 cts.

9844. The Derailment of the Scottish Express at Preston. (Die Entgleisung des Schottischen Expresszuges bei Preston.) H. v. Littow (An examination of the railway accident in Scotland on July 13, 1896, which in the author's opinion was due to too sharp a curve). Zeitschr. d. Oesterr. Ing. u. Arch. Vereines—Dec. 18, 1896.

9912. British Railway Statistics for 1895 (Statement relating to the capital, traffic, working expenditure and profits for the year). Eng News—Dec. 17. 1,000 w. 15 cts.

9930. The First London Railroad. W. B. Paley (Historical account of the London Greenwich Railway, the opening of which, as far as Deptford, was made 60 years ago). R R Gaz—Dec. 18, 1896. 1,200 w. 15 cts.

9966. Indicator Diagrams from Locomotive Schnectady. W. F. Goss (The engine named is mounted for testing purposes in

the laboratory of Purdue Univ., La Fayette, Ind. Part first reviews briefly the precautions that were taken in securing the diagrams to be discussed). Ry Rev—Dec. 19, 1896. Serial. 1st part. 500 w. 15 cts.

9968. Tenth Annual Report of the Inter-State Commerce Commission (A brief reference to some of the subjects treated, with nine amendments to the law which are recommended). Ry Rev—Dec. 19, 1896. 1,800 w. 15 cts.

9971. The Slipping of Locomotives at High Speeds. C. E. Wolff (A series of careful experiments show that such a slip often takes place. The writer attempts to find some satisfactory explanation). Prac Eng—Dec. 11, 1896. 1,000 w. 30 cts.

10024. The Substitution of Electricity for Steam as a Motive Power for Suburban Traffic. John Findley Wallace (A paper intended to introduce the subject for discussion. Investigations made by the writer five years ago are given, with results. Concludes that electricity is more desirable for handling a large number of small transportation units at frequent intervals over short distances, and steam power for handling large units of transportation at high speeds, at infrequent intervals and over long distances). Am Soc of Civ Engs—Dec., 1896. 15,500 w. 45 cts.

10036. The Northeastern Railway Works (Full illustrated detailed description of the Gateshead Works, with drawings of Mr. Worsdell's latest engine). Eng Lond—Dec. 18, 1896. 9,300 w. 30 cts.

10050. Continuous Rails (Editorial discussion of the subject of "cast-molding," not favorable to the practice, especially in England). Elect'n—Dec. 18, 1896. 2,000 w. 30 cts.

10056. Annual Report of the Interstate Commerce Commission (Comment on the report, with brief extracts). R R Gaz—Dec. 25, 1896. 1,600 w. 15 cts.

10057. Train Accidents in the United States in November (Detailed list of the more important accidents, with classified summary.) R R Gaz—Dec. 25, 1896. 2,700. w. 15 cts.

10068. The Railway System of the Island of Java. A. Suethlage (Historical account, with particulars). Ry Rev—Dec. 26, 1896. 700 w. 15 cts.

10079. On Standard Form of Examination of Firemen for Promotion and New Men for Employment (Report of committee with discussion). Trav Engs' Assn Rept—Sept., 1896. 10,000 w. 45 cts.

10110. New Phases of the Connecticut Steam Trolley Contest. Clarence Deming (A statement of the proposed plan for meeting electric competition on its own ground). R R Gaz—Jan. 1, 1897. 2,500 w. 15 cts.

10113. Amendments to the Interstate Commerce Law (Editorial comment on the general good and harm of the act, with examination of the amendments). R R Gaz—Jan. 1, 1897. 1,800 w. 15 cts.

10137. Military Railways in War, Their Construction, Working and Defense. J. A. Ferrier (Lecture delivered at the Royal United Service Inst., Simla. Part first is introductory, with reference made to literature on the subject, comparison of camel power, classification, &c.). Ind Engng—Nov. 28, 1896. Serial. 1st part. 1,800 w. 45 cts.

10164. Receivership and Foreclosures in 1896 (The record for the year shows an increase in the number and mileage of roads placed in the hands of receivers, although the capitalization involved is less). Ry Age—Jan. 1, 1897. 800 w. 15 cts.

10167. An Automatic Indicator on the Western Railroad of France. M. E. Brille (An article translated, rewritten and condensed from a contribution to the "Revue Generale des Chemins de Fer" for Sept., 1896. Illustrated detailed description of apparatus). Am Eng & R R Jour—Jan. 1897. 2,200 w. 30 cts.

10183. Sunday Railway Traffic. L. S. Coffin (Pointing out the necessity for a rest day for railway men). Ry Rev—Jan. 2, 1897. 1,000 w. 15 cts.

10221. Hedley's "Puffing Billy" (Historical account of the invention of the first locomotive to haul cars profitably and to do the work expected, with general remarks). Loc Engng—Jan., 1897. 1,800 w. 30 cts.

10258. A Railroad Testing Laboratory. William O. Webber (Illustrated description of the Chicago, Burlington & Quincy R. R. laboratory at Aurora, Ill.). Mach—Jan., 1897. 1,200 w. 15 cts.

10279. The Teaching of Railroad Mechanical Engineering (Extracts from a paper by H. Wade Hibbard, read at Nov. meeting of the Northwest Railway Club. Presents a plan that has proved satisfactory in the Univ. of Minnesota). R R Gaz—Jan. 8, 1897. 1,400 w. 15 cts.

10282. The Railroads of India (Editorial review of condition as based upon the administration report). R R Gaz—Jan. 8. 1897. 1,200 w. 15 cts.

STREET AND ELECTRIC RAILWAYS.

9698. The Hamilton Radial Electric Railway. F. C. Armstrong (Brief account of a recently constructed system embodying features of approved practice). Can Eng—Dec. 1,200 w. 15 cts.

9753. The Glasgow District Subway

(Brief description, with map and sections). Eng Lond—Dec. 4. 1,400 w. 30 cts.

9765. Comparative Utility of Mechanical Tramway Systems (Summary of a paper by E. A. Ziffer, which was read before the International Tramways Union. Conclusions are based on investigations of contemporary tramway activity in Europe and America). Ry Wld—Dec. 1,000 w. 30 cts.

9766. Electric and Cable Traction in America (Notes on this subject from one who has looked on the developments in this field in America from the point of view of their applicability to British requirements). Ry Wld. Dec. 4,000 w. 30 cts.

9768. Fixed Stopping Stations on Tramways. C. Challenger (Discusses the advantages and disadvantages and gives the plan in vogue on the Bristol electric lines, which appears to give satisfaction). Ry Wld. Dec. 1,700 w. 30 cts.

9792. Test of Conduit Electric Railroad. H. G. Ogden, Jr., and F. W. Heitkamp (Abstract of a thesis presented for the degree of M. E. Briefly describes the Metropolitan Electric Street Railroad of Washington, D. C., and gives summary of plant test and line tests). Sib Jour of Engng—Dec. 1,300 w. 30 cts.

9794. Test of an Electric R. R. Power Station. F. W. Phisterer (A statement of what such a test consists and what may fairly be expected in such work in the way of difficulties and arrangements). Sib Jour of Engng—Dec. 2,400 w. 30 cts.

9799. The Underground Trolley and the Third Rail in Electric Traction (Comment on the proposed further application of electricity on the N. Y., N. H. & H. R. R., and the proposed installation of the Metropoiitan Traction Co., of N. Y.). Sci Am—Dec. 19. 1,000 w. 15 cts.

9923. Notes on the Electric Railway Return. G. W. Knox (Read before the Chicago Elec. Assn. Considers the plans of having a metallic return made up by heavily bonding the rails and using a supplementary wire in connection therewith, and the joining the rails in such a manner as to secure the full value of their current conducting capacity). St Ry Rev—Dec. 15. 5,000 w. 30 cts.

9924. The "Cast-Weld" Joint as a Conductor. Harold P. Brown (Illustrated description of joints and tests made, with results). St Ry Rev—Dec. 15. 1,400 w. 30 cts.

9925. The Misuse of Sand. H. S. Cooper (Discussing how it shall be applied to the rails). St Ry Rev—Dec 15. 1,800 w. 30 cts.

10012. Electric Traction in the United States in 1896 (Report of Messrs. Young and Clark to the Tramways Committee of Glasgow on the principal tramway enterprises in North America. A brief notice of some of the larger systems inspected during their visit to America). Elec Lond—Dec. 18, 1896. 2,500 w. 30 cts.

10059. Cast-Welded Rail Joints. William Baxter, Jr. (Comment on the ideas brought out in M. K. Bowen's paper, with a few extracts). R R Gaz—Dec. 25, 1896. 2,000 w. 15 cts.

10060. Track and Track Joints. Construction, Maintenance and Bonding. M. K. Bowen (Read before the Am. St. Ry. Assn. at St. Louis. Discussion of how to construct and maintain a street railway track, giving special attention to the advantage of having welded joints. Discussion). Elect'n—Dec. 18, 1896. 4,500 w. 30 cts.

10084. The Richmond Traction Co.'s Railway System (Illustrated detailed description). Elec Eng—Dec. 30, 1896. 1,200 w. 15 cts.

10193. The System of the Washington, Alexandria and Mt. Vernon Railway (Illustrated detailed description). St Ry Jour—Jan., 1897. 3,800 w. 45 cts.

10194. The Plant of the Toledo Traction Company (An illustrated account of the extensive system owned and operated by this company, and of other business controlled by them). St Ry Jour—Jan., 1897. 2,000 w. 4o cts.

10195. The Street Railway System of Paris. M. Lavalard (Part first briefly reviews the history and growth and the progress of mechanical traction). St Ry Jour—Jan., 1897. Serial. 1st part. 900 w. 45 cts.

10196. Electric Railway Power Stations in America and the Economic Results of Their Operation. L. D. Tandy (A table gives in detail the operation of a number of stations of various types, including the triple expansion and compound engines, direct connected and belt driven generators, condensing and non-condensing. Also a table of percentage comparison of stations, with additional information). St Ry Jour—Jan., 1897. 1,700 w. 45 cts.

10197. Some British Impressions of American Street Railways. Alexander McCallum (The comments are generally favorable). St. Ry Jour—Jan., 1897. 2,500 w. 45 cts.

10198. The Development of the Modern Electric Railway Car Wheel. P. H. Griffin (The effect of local regulations concerning form of rails, &c., is shown, and the service, material and design discussed). St Ry Jour—Jan., 1897. 1,700 w. 45 cts.

BOOKS OF THE MONTH

BELL, LOUIS, PH.D. POWER DISTRIBUTION FOR ELECTRIC RAILROADS. Street Railway Company, New York. 1897. Cloth, $2.50, postage prepaid.

The purpose of this book has been to place in the hands of those daily concerned in transportation by electric traction a serviceable treatise in which not only general principles are set forth, but in which, also, are presented descriptions of ways whereby methods can be coördinated with principles in every-day practice. In his preface the author disclaims anything like an exhaustive treatise; the aim has been, rather, to make it suggestive. The rapid changes in apparatus would, indeed, have precluded an exhaustive attention to details. The volume contains nine chapters, and the style is clear and concise. The first chapter deals with fundamental principles. Chapter II discusses the return circuit with the practical points which must be met in a successful system. This is followed by a chapter on direct-feeding systems, and another on special systems of distribution. In Chapter V auxiliary sub-stations with power transmission, distributed stations, and cost of power as related to auxiliary stations are presented in a plain, easily-understood way. Chapters VII, VIII, and IX are devoted, respectively, to the different varieties of alternating motors for railway work, to inter-urban and cross-country work, and to fast and heavy railway service. The impression gained from a cursory survey of the contents is that the treatise is the work of an alert, bright, and experienced engineer well up to date in his facts and observations. The illustrations are profuse, a large proportion of them being half-tones.

CARTER, E. TREMLETT, C. E. MOTIVE POWER AND GEARING FOR ELECTRICAL MACHINERY. A Treatise on the Theory and Practice of the Mechanical Equipment of Power Stations for Electric Supply and for Electric Traction. The D. Van Nostrand Co., New York. 1896. Cloth, $5.

"An account of the scientific principles and modern practice in the use of engines for driving dynamos" is, so we are told in the preface, the design of the work, "to be clothed in as simple language as would be consistent with accurate and complete treatment." Accuracy and completeness being thus made paramount, the value of the book must be measured by these standards, and it will not suffer by their most rigorous application. Its comprehensiveness is manifested by its copious index, occupying twelve full double-column pages. The book contains 608 pages, of which 490 are occupied with power generation. Four pages relating to water-power testing follow, and pages 493 to 550, inclusive, deal with the various modes of connecting prime motors with dynamos. This is followed by examples of power stations for electric supply and electric traction (pages 551 to 581, inclusive), and pages 582 to 608 are occupied with appendices (A to G, inclusive), which comprise a table of properties of dry saturated steam; note on Druitt Halpin's system of thermal storage, and an analysis of sundry electric-supply station accounts.

The book is well printed from clear, bold type, and is well illustrated. It is a volume that should find a place in the library of every mechanical engineer.

BOOKS RECEIVED.

Lowe, Joseph G., Simpson, J. M., and Howe, Samuel T. (Railroad Commissioners). Fourteenth Annual Report of the Board of Railroad Commissioners of the State of Kansas for the year ending November 30, 1896. The Kansas State Printing Company, Topeka, Kansas. 1896. Cloth.

Report of the United States Commissioner of Education for the year 1894–1895, Vol. I, Part I. Government Printing Office, Washington, D. C. 1896.

Seventeenth Annual Report of the United States Geological Survey. 1895-96, Part III (continued). Mineral Resources of the United States, 1895. Non-metallic Products, except Coal. Government Printing Office, Washington, D. C. 1896. Cloth.

Seventeenth Annual Report of the United States Geological Survey 1895-96. Part III. Mineral Resources of the United States. 1895. Metallic Products and Coal. Government Printing Office, Washington, D. C. 1896. Cloth.

Building and Engineering Trade Directory for 1896–'97. F. W. Dodge, Boston. Cloth, $2

Transactions of the Wisconsin Academy of Sciences, Arts, and Letters. Vol. X. 1894–95. Edited by the secretary. Democrat Printing Co., State Printer, Madison, Wis. Paper.

BOOKS ANNOUNCED.

Andrews, T. Thermo-Electric Reactions and Currents Between Metals in Fused Salts. Spon & Chamberlain, New York. 1896. Paper, 40c.

Bedell, F. The Principles of the Transformer. D. Van Nostrand Co., New York. 1895. Cloth, $3.25.

Bushell, S. W., M. D. Oriental Ceramic Art. Illustrated by examples from the collection of W. T. Walters, with 115 plates in colors and over 400 reproductions in black and white, with text and notes. Appleton, N. Y. 1896. Ten sections, each with forty plates and in leather portfolio. Edition limited to five hundred copies. Subscription price for complete work, $500.

Frith, H. and Rawson, Stepney. Coil and Current, or, The Triumphs of Electricity. Ward, Lock & Co., New York. 1896. Cloth, $1.25.

Houston, Edwin J., and Kennelly, Arthur Edwin. (*a*) The Electric Motor, (*b*) Electric Telegraphy; (*c*) Electric Telephony; (*d*) Electric Street Railways. The W. J. Johnston Co., New York. 1896. Uniform cloth, each $1.

The Mechanics' Lien Law of the State of New York (Passed May 27, 1885). Revised and enlarged with all the amendments, and applicable to the entire State; also the lien laws as to municipal property in incorporated cities, railroads, oil-wells, etc., With notes of judicial decisions, and a full collection of forms compiled by W. L. Snyder. Third edition. Baker, Voorhis & Co., New York. 1896. Half sheep, $3.

Sharp, Archibald. Bicycles and Tricycles. An elementary treatise on their design and construction, with examples and tables. Longmans, Green & Co., New York. 1896. Cloth, $4.

Hopkins, W. Rowland. The Street Railway Problem in Cleveland. A Statement of Existing Conditions and the Policy Which the City Should Pursue with Regard to its Street Railways. The Macmillan Co., New York. 1896. Paper, 75c.

Perkins, C. A. Outlines of Electricity and Magnetism. M. Holt & Co., New York. 1896. Cloth, $1.10.

Miller, J. H. (of the San Francisco Bar). Dredging on the Pacific coast. Illustrated description of various dredging machines, and comparisons of their performance. John H. Miller, San Francisco. 1896. Paper.

Coleman, T. E. Sanitary House Drainage: Its Principles and Practice. A Handbook for Architects, Engineers, and Builders. Spon & Chamberlain, New York. 1896. Cloth. $2.

Cooper, J. H. A Treatise on the Use of Belting for the Transmission of Power. New issue. Fourth edition. D. McKay, Philadelphia, Pa. Cloth, $3.

Kapp, Gisbert. Transformers for Single and Multiphase Currents. A Treatise on their Theory, Construction, and Use. Translated from the German by the author. The Macmillan Co., New York. 1896. Cloth, $1.75.

Meadowcraft, W. H. A B C of Electricity. New Issue. American Technical Book Co. New York. 1896. Cloth, 50c.

Poor, H. V. Poor's Manual of Railroads of The United States for 1896. H. V. & H. W. Poor, New York. 1896. Cloth, $7.50.

Ramsey, W. The Gases of the Atmosphere. The History of Their Discovery. The Macmillan Co., New York. 1896. Cloth, $2.

Robinson, H. Sewage and Sewage Disposal. Spon & Chamberlain, New York. 1896. Cloth, $4.50.

Rothwell, R P. The Mineral Industry: Its Statistics, Technology, and Trade in the United States and Other Countries, from the Earliest Times to the End of 1895. The Scientific Publishing Co., New York. 1896. Cloth, $5.

Thompson, Sylvanus Phillips. Polyphase Electric Currents, and Alternate Current Motors. American Technical Book Co., New York, 1896. Cloth, $2 75.

Roper, Stephen. Simple Process for Estimating the Horse-power of Steam Engines from Indicator Diagrams. New issue. D. McKay, Philadelphia. 1896. Cloth, 50 cents.

Roper, Stephen. Use and Abuse of the Steam Boiler. New issue. D. McKay, Philadelphia. 1896. Morocco, $2.

Roper, Stephen Young Engineers' Own Book. Principles and Theories of the Steam Engine as a Prime Mover. D. McKay, Philadelphia. 1896. Morocco, $3.

Saward, B. C. Decorative Painting. A Practical Handbook. Charles Scribner's Sons. New York. 1896. Cloth, $1.25.

Jackson, C. F. Mechanical Drawing. J. B. Lippincott Co., Philadelphia. 1896. Buckram, $1.50.

Kittredge, G. W. The New Metal-Worker Pattern Book. A Treatise on the Principles and Practice of Pattern Cutting as Applied to Sheet Metal Work. D. Williams, New York. 1896. Cloth, $5.

McNeill, T. E. Steam and Hot Water Fitters' Text-Book. D. Williams, New York. 1896. Cloth, $1.

Practical Gas-Fitting. Reprint from The Metal Worker. D. Williams, New York. 1896. Cloth, $1.

Norris, W. A Practical Treatise on the "Otto" Cycle Gas Engine. Longmans, Green & Co., New York. 1896. Cloth, $3.

Shaler, N. S. American Highways. A Popular Account of Their Conditions and of the Means by which they may be Bettered. The Century Co., New York. 1896. Cloth, $1.50.

Thresh, J. C. Water and Water Supplies. Imported by W. B. Saunders, Philadelphia. 1896. Cloth, $2.25.

Trowbridge, J. What is Electricity? D. Appleton & Co., New York. 1896. International Scientific Series, No. 75. Cloth, $1.50.

IMPROVED MACHINERY

NEW PROCESSES. NEW APPLIANCES.

The matter published in this department is not paid for, nor can it be classed as advertising But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

The "Gladiator" Bicycles.

ALL the world is at the present time, so to speak, on wheels. The bicycle in some form seems almost omnipresent. Whether on crowded city streets, or in narrow country by-ways, one need not wait long before the familiar sight appears, among them,—ranking with the best of all, —the one herewith illustrated. The manufacturers bring strong evidence to sustain their claim that the "Gladiator" is the best wheel in market. Without ourselves attempting to decide so difficult a question, we will state the evidence and leave readers to form their own judgment.

THE GLADIATOR LIGHT ROADSTER NO. 40.

The employees of the Edward P. Allis Co., the noted steam engine builders at Milwaukee, Wis., desired to purchase in a single lot a considerable number of highest grade bicycles for their own use. In order to get the best, they requested samples of various makes for testing purposes, and tested them for two weeks in the same skilful and thorough way that they would test any other machine. The result was that they purchased the high-grade, high-priced "Gladiator." That such men by such a method reached such a conclusion is considered proof that this wheel is inferior to none, and is superior to most if not all wheels now on the market.

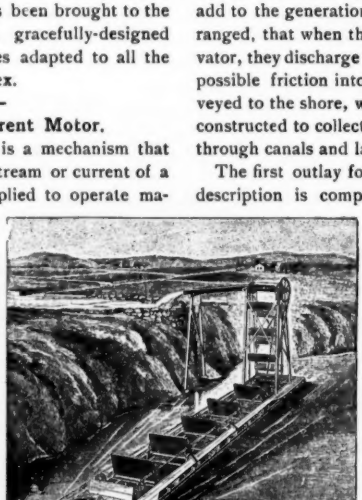
Out of the numerous styles of this wheel produced, we select the light roadster, No. 40 of catalogue, for purposes of illustration. It is an extremely pretty model, and combines the points of excellence running through the whole line of wheels made by the Gladiator Cycle Works, at 109 to 115 West Fourteenth street, Chicago, Ill. These works possess all modern appliances and the most improved machinery necessary to produce the highest grade of goods, and every man in their employ is an expert. No cheap or inexpensive workmen are employed, and each department is under charge of an assistant superintendent thoroughly conversant with every feature of his department. All material is purchased by men of long experience, and is the best that money can buy. The frames are made from Mannesmann drawn steel tubing, imported direct; and the connections are hammered out of the finest crucible steel. Hubs on all styles are turned out of tool-steel, and no tubing is used in

their manufacture. The two-point contact bearing is used, and large balls are a feature, making the most easy, silent-running bearing yet produced. All cups and ball-races are perfectly tempered and ground, and no case-hardened or stamped cones are used. The cones being the most important part of a bicycle the manufacturers have devoted the utmost attention to their perfection. The same care and skill have been extended to all other parts of the machine, and the "Gladiator" has thus been brought to the very front as a reliable, gracefully-designed wheel, in its several styles adapted to all the needs of cyclists of either sex.

The Austin Current Motor.

THE "Current Motor" is a mechanism that utilizes the power of the stream or current of a river so that it can be applied to operate machinery. The F. C. Austin Manufacturing Company, of Chicago, Illinois, claims to be the pioneer of a practical current motor.

A dam is only available where the conditions are favorable. The current motor, however, can be used without a dam, in any river, in any location in the river where water is deep enough to admit it. A current motor can be applied for generating electricity for electric-lighting purposes, and for various machines used on a farm now run by steam, but its chief use will be in connection with irrigation and mining.



AUSTIN CURRENT MOTOR.

In many localities in the west, and in fact all over the country, the land adjacent to the river is too high to admit of the water being conveyed to it through ditches by means of gravity. Under such conditions the land is now generally not irrigated, except to a limited extent where vegetables and fruit are raised. To such localities the Austin Current Motor will prove a boon.

This motor has been experimented with and tested thoroughly, and its practicability demonstrated. The only limits to the power, and consequently to the amount of water that can be pumped by it, are the dimensions of the paddles, the number of them, and the force of the current.

The machine, anchored in the river, consists of a pontoon carrying two endless chains, to which are pivotally attached at suitable distances reversible paddles having floats at their upper ends that buoy them up in their course through the water. By an ingenious device these paddles enter and leave the water in such a way that they do not detract from the efficiency of the machinery, but, on the contrary, rather add to it. To the wheels put in motion by these cables is attached an elevator carrying large buckets, which, when entering the water to fill themselves, add to the generation of power, and are so arranged, that when they reach the top of the elevator, they discharge their contents with the least possible friction into a trough, there to be conveyed to the shore, where a reservoir has been constructed to collect the water and distribute it through canals and lateral ditches over the land.

The first outlay for a current motor of this description is comparatively small when the enormous enhancement of the value of the land is considered, and the cost of running it is nominal. It works incessantly day and night without an attendant, and, if the capacity of the reservoir is sufficient, a large volume of water may be accumulated to be used at the proper season.

Something Pertinent to the Times.

THE Berlin Iron Bridge Co., of East Berlin, Conn., has received from their representative at C. Lerdo, Mexico, the contract for an iron market house at Guadalajara. If this market house were built anywhere in the United States and paid for in our own money, the contract price would be $5,615.00. The Berlin Co. is however, to receive in payment for this building Mexican silver dollars and, therefore, their contract price with the city of Guadalajara is $11,230.00.

If Mr. Bryan and his Populistic platform should prevail and there should be free coinage of silver on the basis of 16 to 1, what is to prevent the Berlin Iron Bridge Co. from taking the dollars which it receives in payment on this building (each one of which contains more silver than the American dollar) to the United States mint and, free of expense, have them coined into American silver dollars? Under free silver it would then receive for the building 11,230

Bryan dollars, which he claims will be worth as much as gold dollars, consequently they can be used in paying the employees, thus leaving the company a clear profit of over $5,000.00 on this one contract. Or, again, it can take the 11,230 standard silver dollars and with them pay the labor and expense of building another market house, another bridge, or building for the Mexican market, and receive for the same 22,460 Mexican dollars. It can then recoin these, free of expense, into American dollars and thus by each transaction double the money. Does any laboring man in this country believe that labor paid for in money of that kind will have the purchasing power of our present dollar? Would there be any difference in paying labor in those dollars and in reducing the present rate of wages 50%? Under the circumstances, which will be benefitted by free coinage,—capital or labor?

A Severe Test of Porous Terra Cotta.

"A MOST severe fire and water test of the standard material so generally used for constructing fire-proof buildings, consisting of hollow clay tiles for floors and ceilings, was made recently in this city, under the supervision of the Building Department.

"After a continued firing of six hours with over 2,000 degrees of heat, obtained in the building erected for the test, the Fire Department was called to extinguish the fire, which they did by putting on water, under a sixty-pound pressure, for over half an hour, without doing any amount of damage to either floor or ceiling, proving that clay is a most remarkable material for resisting fires in buildings. On the whole, the aforesaid test was very satisfactory in every particular, showing that our buildings can be made fire-proof, constructed with such material."

The above, from the *Times* (New York) refers to the porous terra cotta manufactured by Henry Maure and Son, 420 East Twenty-third street, New York, who are extensive producers of fire-proof building materials.

Remarkable Speed Regulation.

WE believe that the example of speed regulation under the trying conditions of street railway service shown in the accompanying diagram has never been excelled, if equaled. In fact, if it can be excelled there is so small a margin between this regulation and mathematical exactness that the feat would be of scarcely any practical value. The diagram shows that the speed remains practically constant. It will be of interest to all engaged in steam-engineering, and to the mechanical fraternity generally. The

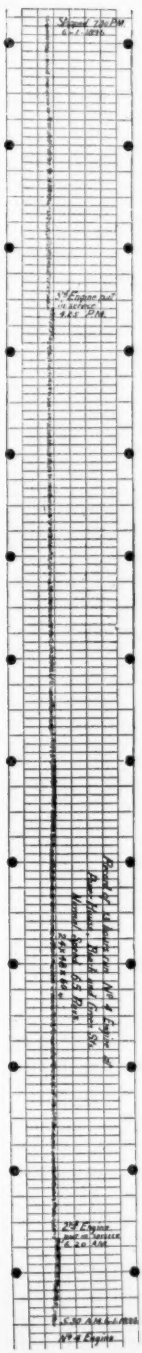


DIAGRAM SHOWING SPEED REGULATION OF TWIN, TANDEM, COMPOUND, DIRECT COUPLED ENGINES, BUILT BY THE EDWARD P. ALLIS CO., MILWAUKEE, WIS. CYLINDERS 24" AND 48" DIAMETER, 60" STROKE. PEOPLES TRACTION CO., PHILADELPHIA, PA.

legend explains everything except the fact that the record was obtained by a Moscrop recording gage.

The Edson Pressure-Recording and Alarm Gage.

PRE-EMINENT among instruments for indicating the conditions of care and attendance bestowed upon steam generating installments, and the uniformity,—or want of it,—with which steam has been maintained, is the Edson pressure-recording and alarm gage an illustration of which is herewith presented.

As a corollary, the measure of economy with which the steam has been produced is also indicated by this instrument, because uniformity of a prescribed pressure implies uniform firing and boiler feeding, both essential conditions to highest economy in steam generation. Other economies resulting from the uniform care in attendance and firing are a longer life in the boiler and the maintenance of the cut-off in the steam-cylinder at the most economical point, thus obtaining the full value of the steam expansion in the generation of power. The means for detecting any lapse of the performance of duty in firing and feeding is supplied by this instrument, so that the proper and needed discipline may at any and all times be enforced.

Two distinguishing points of this gage, which merit particular

attention, are the corrugated solid steel diaphragm spring in the base of the instrument, from which a direct connection is made to the movement, and the simplicity of the movement itself, there being no cogs or gears of any description.

Its merits have secured to the instrument a very wide popularity and have brought it into extensive use. The very general approval of the instrument by steam users is expressed in the following extract from a report upon it by The Franklin Institute, which says: "It can safely be affirmed that the Edson gage has proved itself in service to be a reliable and well-made instrument, which has successfully stood the severe test of time, and it can safely be recommended to every owner of a steam boiler in the interests of safety and economy."

THE EDSON PRESSURE-RECORDING AND ALARM GAGE.

Three styles are made. No. 1 is the style herewith illustrated. It has an adjustable circuit-closer for high pressure operating an electric bell located on the instrument.

Style No. 2 has an adjustable high-pressure circuit closer arranged to ring a bell at a distance. Style No. 3 has no circuit-closer. An adjustable circuit-closer for sounding an electric bell when the pressure falls below a prescribed limit can, when desired, be added at a trifling cost. With the instrument,—included in its price,—go a year's supply of charts, numbered consecutively for each day in the year, and ruled to the special scale of the instrument; one special album for filing away charts daily as records are made upon them; one lot of shelf and brackets, boxing and shipping. The instrument is made solely by the Ashcroft Manufacturing Co., 111 Liberty street, New York.

NEW TRADE CATALOGUES.

The Van Auken Steam Specialty Co., Chicago, Ill., U.S.A.=Folding circular, illustrating and describing the "Star" lead pipe couplers and fittings, for making pipe joints without the use of solder. A complete plumbing job is shown without the use of an ounce of solder.

Pneumatic Engineering Company, New York. =(*a*) Pamphlet illustrating and describing air hoists for use in machine-shops, architectural iron works, foundries, quarries, and in any business where chain blocks or hand-cranes have hitherto been used. (*b*) Pamphlet illustrating the "air-lift" system of pumping, and setting forth its simplicity and economy; with descriptive text.

Cleveland Twist Drill Company, Cleveland, Ohio, U.S.A.=Illustrated and descriptive catalogue of "Increase-Twist Drills," and "Self-Feeding Reamers."

Bignall & Keeler Manufacturing Company, St. Louis, U.S.A.=Catalogue No. 13 of the "Peerless" and "Duplex" pipe threading and cutting machines; illustrating and describing these tools. With price lists, and numerous tables of data relating to pipes.

Buffalo Forge Company, Buffalo, N. Y., U.S.A.=Pamphlet illustrating and describing the "Buffalo" disc wheels for exhausting, ventilating, and cooling.

Theo. Alteneder & Sons, Philadelphia, Pa.=Catalogue and price list, illustrating and describing "Imperial German" drawing instruments.

American Gas Furnace Company, Elizabeth, N. J., U.S.A. (Office, 80 Nassau street, New York.)=(*a*) Pamphlet, 17th revised edition, illustrating and describing the fuel gas system controlled by this company and applicable to the production of heat, light, and power for manufacturing purposes exclusively. (*b*) Special Bicycle Supplement to Illustrated Catalogue illustrating and describing special appliances for bicycle work, such as brazing tables, forges and ovens, case hardening furnaces, and gas blast radiators for heating japan ovens.

Mitts & Merrill, Saginaw, Mich., U.S.A.=Illustrated pamphlet, describing the "Giant" key-seater or splining machine.

Nelsonville Foundry and Machine Company, Nelsonville, Ohio, U.S.A.=Illustrated and descriptive catalogue of haulage, hoisting, and stationary engines, mine and mill furnishings and supplies.

The Crescent Sheet and Tin Plate Company, Cleveland, Ohio, U.S.A.=Pamphlet describing and setting forth the merits of the tin and terne plates manufactured by this company.

Watertown Steam Engine Company, Watertown, N. Y., U.S.A.=Catalogue of steam engines,—simple, compound, horizontal, and vertical.

The Van Duzen Gasoline-Engine Company, Cincinnati, Ohio, U.S.A.=(*a*) Illustrated descriptive catalogue of a line of gasoline and gas engines. (*b*) Pamphlet containing testimonials to the Van Duzen gasoline and gas engine.

Universal Construction Company, Chicago, Ill., U.S.A.=Pamphlet illustrating and describing steel cars, steel underframes, and car-truck channels.

J. H. Sternbergh & Son, Reading, Pennsylvania, U. S. A.=Illustrated catalogue and price-list of bolts, nuts, washers, rivets, lag screw, turn-buckles, track bolts, rods and irons for bridge-building, etc.